STAR

Scientific and Technical Aerospace Reports

SEMIMONTHLY ABSTRACT JOURNAL

MAY 11 1968

APRIL 23, 1968

VOLUME 6 • NUMBER 8

N68-17218—N68-18255

DOCUMENTS DEPT.

MAY 8 1968

Duke University Library

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PURCHASE OF *STAR*

The semimonthly issues and the cumulative index issues are available postpaid on subscription and in single copy from the Superintendent of Documents, United States Government Printing Office, Washington, D.C., 20402, United States of America.

Semimonthly issues...

Annual subscription rate: $33.00, domestic; $42.00, foreign. Price per single copy: $2.25, domestic; 25c extra for foreign mailing.

Cumulative index issues...

Annual subscription rate: $30.00, domestic; $35.00, foreign. Price per single copy varies according to the number of pages.

Domestic subscription rates...

Apply to the United States, Canada, Mexico, and all Central and South American countries, except as noted below.

Foreign subscription rates...

Apply to Argentina, Brazil, French Guiana, Guyana, Surinam, British Honduras, and all other countries throughout the world.

Payment should be by check, money order, or document coupons, and must accompany order. Remittances from foreign countries should be made by international money order, or draft on an American bank, payable to the Superintendent of Documents, or by UNESCO book coupons.

PUBLISHED BY:
UNITED STATES GOVERNMENT
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SCIENTIFIC AND TECHNICAL INFORMATION DIVISION

Scientific and Technical Aerospace Reports, Volume 6, is prepared by the NASA Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by Documentation Incorporated.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 7, 1966.

Introduction

WHAT *STAR* IS

Scientific and Technical Aerospace Reports (STAR) is a comprehensive abstracting and indexing journal covering worldwide report literature on the science and technology of space and aeronautics. It is published twice each month.

The following publications are abstracted in *STAR*:

Scientific and technical reports of the National Aeronautics and Space Administration and its contractors; scientific and technical reports of government agencies, universities, and research organizations throughout the world.

HOW *STAR* IS ORGANIZED

The first section of *STAR* contains bibliographic citations and abstracts arranged in 34 subject categories. Following the abstract section are five indexes: subject, personal author, corporate source, report/accession number, and accession/report number. Separate cumulative indexes are published quarterly, the fourth quarterly being an annual index for the calendar year. Cumulative indexes contain a contract number index in addition to the indexes indicated above.

HOW TO USE *STAR*

Readers are encouraged to examine abstracts in each subject category of interest. If time is short, readers may wish to scan the subject index for items of interest in a specific area. A more thorough coverage of a subject field may often be achieved by detailed examination of the subject index in the quarterly cumulative indexes, inasmuch as the cumulatives contain cross references between related subject terms.

AVAILABILITY OF *STAR* AND DOCUMENTS

NASA documents (identified by an asterisk in the abstract section and in the report/accession number and accession/report number indexes) and *STAR* are available without charge to:

1. NASA Offices, Centers, contractors, subcontractors, grantees, and consultants.
2. Other U. S. Government agencies and their contractors.
3. Libraries in the United States that have arrangements with NASA to maintain collections of NASA documents for public use.
4. Other organizations in the United States having a need for NASA documents in work related to the aerospace program.
5. Foreign government or academic (university) organizations that have established reciprocal arrangements for the exchange of publications with NASA, that have current agreements for scientific and technical cooperative activities with NASA, or that have arrangements with NASA to maintain collections of NASA documents for public use.

European requesters may purchase facsimile copy or microfiche of NASA documents, identified by a pound sign (#), from ESRO/ELDO Space Documentation Service, European Space Research Organization, 114, av. de Neuilly, 92–NEUILLY sur Seine, France.

Advisory Group for Aerospace Research & Development (AGARD) reports that are not copyrighted will be made available on the same basis as NASA documents.

Department of Defense documents (identified by the "AD" number in the citation) are available without charge to U.S. Government-sponsored research and development activities from the Defense Documentation Center (DDC), Cameron Station, Alexandria, Virginia 22314. Department of Defense documents are not available from NASA.

Other non-NASA documents are provided by NASA without charge only to NASA Offices, Centers, contractors, subcontractors, grantees, and consultants. Foreign non-copyrighted documents will be provided to U.S. Government Agencies and their contractors.

Documents that have been placed on microfiche (a transparent sheet of film, approximately 4×6" in size, capable of containing an orderly arrangement of 60 or more pages of information reduced to micro images) are identified with the symbol #. Microfiche are available on the same basis as hard copy.

HOW TO REQUEST LISTED DOCUMENTS

If you are registered with NASA, send a completed *Document Request* (Facility Form 492) to:

NASA Scientific and Technical Information Facility
P. O. Box 33
College Park, Maryland 20740

If you are not registered with NASA, but are eligible to receive documents without charge according to the information on the previous page in the section on Availability of *STAR* and Documents, request Registration Form—Technical Publications (Facility Form 713) from the above address.

HOW THE PUBLIC MAY OBTAIN LISTED DOCUMENTS

For reference purposes, NASA documents listed in *STAR* may be consulted at one of the organizations listed on the inside back cover. Commercial publications listed in *STAR* may be consulted in libraries or purchased from publishers or booksellers.

The public may purchase NASA documents and non-copyrighted foreign documents, including AGARD reports, from either of the following sales agencies as specifically identified in the abstract section:

Clearinghouse for Federal Scientific and Technical Information
(CFSTI)
Springfield, Virginia 22151

Superintendent of Documents, U. S. Government Printing Office
(GPO)
Washington, D. C. 20402

Documents available from CFSTI are sold in hard copy and microfiche form. If a printed hard copy is not available, a facsimile copy is provided. The symbols "HC" and "MF" are used in the abstract section to designate the copy available: "HC" (hard copy) for full size or facsimile; "MF" for microfiche. A unit price policy has been established by CFSTI: $3.00 for printed hard copy or facsimile copy; $0.65 for microfiche.

Not all NASA documents, however, are subject to this policy. Documents available from Superintendent of Documents which are also available from CFSTI are sold at the Superintendent of Documents price, and other selected NASA publications will continue to be priced according to previous practices. In all cases, the *STAR* citation includes the specific sale price which applies.

Following the availability information in the citation of each NASA-supported document is a code, e.g., CSCL 25A, indicating the subject category assigned to that document from the *COSATI Subject Category List* (first ed., December, 1964) published by the Committee on Scientific and Technical Information of the Federal Council for Science and Technology.

The public may request non-NASA documents by writing to the source or other information systems. Bibliographic information, e.g., report number, etc., rather than the NASA accession number (i.e., N68-12345) should always be provided when requesting such a document from its source.

ABSTRACTS OF JOURNAL ARTICLES

By arrangement between NASA and the American Institute of Aeronautics and Astronautics, the AIAA publication *International Aerospace Abstracts* is issued in coordination with *STAR*. Each journal appears on alternate weeks. *IAA* uses subject categories identical with those in *STAR*, and publishes similar indexes. *IAA's* worldwide coverage of books and scientific and trade journals complements *STAR's* worldwide report coverage. The two publications thus provide comprehensive access to current literature on aerospace science and technology.

Organizations having a NASA contract may obtain *IAA* by writing NASA, Code USS-A Washington, D. C. 20546. Others should direct inquiries to the American Institute of Aeronautics and Astronautics, 750 Third Avenue, New York, N. Y. 10017.

Annual subscription rates for *IAA:*

Semimonthly issues: United States and Possessions, $33.00 postpaid; Foreign Countries, $42.00 postpaid.

Cumulated Index Volumes: United States and Possessions, $30.00 postpaid; Foreign Countries, $35.00 postpaid.

INDEXING VOCABULARY

The Preliminary Edition of the *NASA Thesaurus* (December 1967) (NASA SP-7030) is being used as the authority for the indexing vocabulary that appears in the subject index to this issue. The terminology has been modified from the *Guide to the Subject Indexes for STAR* (NASA SP-7016), the authority used for the vocabulary to indexes published prior to 1968. The *NASA Thesaurus* should be consulted for a total picture of the current indexing vocabulary including associated cross reference structure. Only the subject terms that have been selected to describe the documents abstracted in this issue appear in the subject index. Copies of the *NASA Thesaurus* may be obtained from the Clearinghouse for Federal Scientific and Technical Information or the U. S. Government Printing Office at a price of $8.50 for the three-volume set.

Volume 6 Number 8 / April 23, 1968

TABLE OF CONTENTS

Subject Categories

Abstracts in the journal are grouped under the following categories:

page:

01 AERODYNAMICS
Includes aerodynamics of bodies, combinations, internal flow in ducts and turbomachinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion. **1105**

02 AIRCRAFT
Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **1108**

03 AUXILIARY SYSTEMS
Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems. **1118**

04 BIOSCIENCES
Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology. **1125**

05 BIOTECHNOLOGY
Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences. **1134**

06 CHEMISTRY
Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants. **1138**

07 COMMUNICATIONS
Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **1145**

08 COMPUTERS
Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics. **1151**

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation. **1153**

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories. **1155**

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations. **1156**

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion. **1160**

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences. **1166**

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras. **1175**

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; reliability; drafting; and materials fabrication, handling, and inspection. **1182**

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid-State. **1183**

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see : 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics. **1184**

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics. **1189**

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers. **1192**

20 METEOROLOGY
Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences. **1195**

21 NAVIGATION
Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications. **1198**

22 NUCLEAR ENGINEERING
Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems. **1200**

23 PHYSICS, GENERAL
Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics, 20 Meteorology, and 29 Space Radiation. **1208**

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR
Includes atomic, molecular and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation. **1211**

25 PHYSICS, PLASMA
Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems. **1217**

26 PHYSICS, SOLID-STATE
Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics. **1221**

27 PROPELLANTS
Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems. **1228**

28 PROPULSION SYSTEMS
Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants. **1229**

29 SPACE RADIATION
Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear. **1233**

30 SPACE SCIENCES
Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbits and trajectories. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles. **1235**

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics. **1244**

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic. **1245**

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants. **1254**

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents. **1261**

SUBJECT INDEX I-1

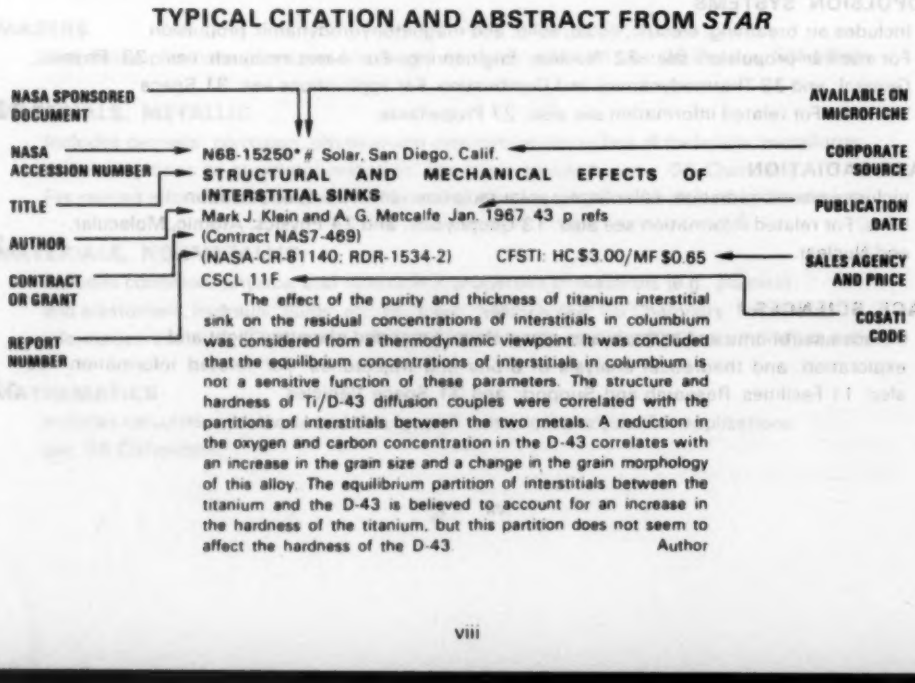
PERSONAL AUTHOR INDEX I-59

CORPORATE SOURCE INDEX I-83

REPORT/ACCESSION NUMBER INDEX I-97

ACCESSION/REPORT NUMBER INDEX I-105

TYPICAL CITATION AND ABSTRACT FROM *STAR*


NASA SPONSORED DOCUMENT
AVAILABLE ON MICROFICHE
NASA ACCESSION NUMBER
N68-15250* # Solar, San Diego, Calif.
CORPORATE SOURCE
TITLE
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
PUBLICATION DATE
AUTHOR
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
CONTRACT OR GRANT
(NASA-CR-81140; RDR-1534-2) CFSTI: HC $3.00/MF $0.65
SALES AGENCY AND PRICE
CSCL 11F
COSATI CODE
REPORT NUMBER
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

VOLUME 6 NUMBER 8 / APRIL 23, 1968

Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N68-17304# Royal Aircraft Establishment, Farnborough (England).
BOUNDARY LAYER INTERACTION EFFECTS IN INTAKES WITH PARTICULAR REFERENCE TO THOSE DESIGNED FOR DUAL SUBSONIC AND SUPERSONIC PERFORMANCE
J. Seddon Mar. 1966 35 p refs
(RAE-TR-66099) CFSTI: HC $3.00/MF $0.65

The nature of flow in intakes with external boundary layer, at subsonic and supersonic speeds, is described. On the basis of a systematic series of wind tunnel tests, a quantitative assessment is made of the loss of pressure recovery due to interaction between the boundary layer and the pre-entry pressure gradient, including when present the normal shock. The analysis leads to a formula which is suggested for general application. Boundary layer control to reduce or eliminate the interaction loss may require to take special form when it is necessary not only to safeguard the supersonic performance but also to minimise the subsonic drag. Some brief discussion of this problem is given. Author

N68-17306# Royal Aircraft Establishment, Farnborough (England).
FURTHER EXPERIMENTAL RESULTS ON THE MUTUAL INTERFERENCE BETWEEN SEPARATED WINGS AND BODIES AT M = 2.49
P. H. Cook Jul. 1966 92 p refs
(RAE-TR-66228)

The mutual interference between a number of wing and body combinations has been measured at a Mach number of 2.49 and a Reynolds number of 3.2×10^6/ft. The wing and body were mounted on separate parallel stings (in a common housing) one of which moved vertically and the other longitudinally. Thus lift, drag and pitching moment could be measured on both wing and body, each in the presence of varying amounts of interference from the flow field of the other. A sonic leading edge delta wing was tested with three bodies of equal length and volume and differing profiles, and a wing with a hyperbolic leading edge was tested with one cone body. When compared with isolated wing plus isolated body results, increases of up to 14% in $(L/D)_{max}$ have been measured due to favourable interference. Author

N68-17446*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ON NONLINEAR LONGITUDINAL DYNAMIC STABILITY
Murray Tobak *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 161–173 refs (See N68-17439 08-02) CSCL 01B

The applicability of functional analysis in approximations of aircraft nonlinear longitudinal stability is discussed. S.C.W.

N68-17456# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
PROGRESS IN TECHNIQUES FOR MEASURING AERODYNAMIC DERIVATIVES BY FORCED OSCILLATIONS METHOD IN WIND TUNNEL [PROGRES REALISES DANS LES TECHNIQUES DE MESURE DES DERIVEES AERODYNAMIQUES EN SOUFFLERIE METHODE D'OSCILLATIONS FORCEES]
Michel Scherer and Joseph Lopez *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 409–436 refs In FRENCH (See N68-17439 08-02)

Progress by ONERA is reported for the measuring of aerodynamic derivatives by forced oscillations methods and a comparison is made between these and measures in flight. Development of the installations where forced oscillations can be made is described, including transonic and supersonic wind tunnels. Methods of measurement are detailed, and an overview of results obtained during the past four years is presented. Transl. by M.W.R.

N68-17458# Royal Aircraft Establishment, Bedford (England).
LOW-SPEED INVESTIGATIONS USING FREELY-FLYING MODELS
P. L. Bisgood *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 481–494 refs (See N68-17439 08-02)

Although freely flying models were used extensively in the very early days of aviation, their use in post-war research has been confined until recently, to studies of the transonic and supersonic regimes on the one hand and studies of spinning characteristics on the other, while the potentialities of the freely flying model as a means of investigating a wider variety of problems, particularly at low airspeeds, often have been neglected. It is the purpose of this paper to consider some of these potentialities and to discuss some of the techniques that have been used and the results that have been obtained in recent tests using free flying models at low speeds. Author

N68-17555*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
INVISCID HYPERSONIC FLOW OVER A BLUNT BODY WITH HIGH RATES OF MASS AND HEAT TRANSFER
E. Dale Martin Washington Mar. 1968 54 p refs
(NASA-TN-D-4252) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A study of steady hypersonic flow over a blunt body with a very high rate of continuous mass transfer from the body surface.

with heat conduction, is presented. An approximate analysis is made of the inviscid flow over a sphere with large mass flux. Lighthill's well-known constant-density inviscid blunt-body flow solution was previously extended by Vinokur and Sanders and by Cresci and Libby to include inviscid flow at a high rate out of the body surface. The present analysis further extends Cresci and Libby's solution to include the effects of the boundary shock wave, a thin viscous region dominated by viscous-compressive stresses (rather than viscous shear) and the associated heat conduction in the gas adjacent to the body surface. These effects are important to consider when there is a significant source of translational nonequilibrium at the body surface (such as absorption of intense radiation and the accompanying large heat conduction). Author

N68-17558# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Aachen (West Germany). Inst. fuer Theoretische Gasdynamik.

INTERMEDIATE BALLISTICS INVESTIGATIONS ON WING STABILIZED PROJECTILES [ZWISCHENBALLISTISCHE UNTERSUCHUNGEN BEI GEWOEHNLICHEN FLUEGELSTABILISIERTEN GESCHOSSEN]

W. Gretler Dec. 1967 31 p refs In GERMAN; ENGLISH summary

(DLR-FB-67-92)

For a strongly idealized flow model simple formulas are derived in order to estimate the effects of impact. Especially, the dependence of the angle of attack of the wing on the angle of attack of the projectile is specified. From this the influence of the projectile data and the conditions at the muzzle upon the impact force and upon the projectile incidence can be easily seen. It is found out that the impact force is negligible because of the small impact time, except in the case of very large transverse forces i.e. at very large muzzle-momentum (see eq. 24). Further it is deduced from eq. 36 that even at extremely high muzzle-momentum a notable incidence can only be obtained for projectiles having low transverse moments of inertia. Author

N68-17593*# Lockheed Missiles and Space Co., Sunnyvale, Calif.

STEADY AND UNSTEADY TERMINAL SHOCK AERODYNAMICS ON CONE CYLINDER BODIES

Lars Eric Ericsson Oct. 1967 79 p refs

(Contract NAS8-20354)

(NASA-CR-61560; LMSC-L-87-67-2) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The effects of shock-induced boundary-layer separation on cone-cylinder body aero-dynamics have been studied. At high subsonic speeds, the local supersonic flow region aft of the cone-cylinder shoulder is terminated by a normal shock. The resulting boundary-layer separation is shown to change the vehicle aerodynamics appreciably. At a certain critical angle-of-attack, complete leeward-side flow separation occurs which drastically affects the vehicle dynamics, in particular elastic vehicle dynamics. Analytical methods are developed that relate steady and unsteady aerodynamics for the two types of flow separation. Author

N68-17625# Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).

TRANSONIC POTENTIAL FLOW AROUND A FAMILY OF QUASI-ELLIPTICAL AEROFOIL SECTIONS

G. Y. Nieuwland (Ph.D. Thesis—Univ. of Groningen) Jul. 1967 71 p refs

(T-172)

Transonic potential flows around non-lifting and lifting aerofoils are obtained, based on a new development of the hodograph theory of Chaplygin, Cherry and Lighthill. Practical examples are shown. Physical aspects (transonic controversy) are discussed in an appendix. Author

N68-17880*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

EFFECTS OF LEE-SURFACE VOLUME ADDITION ON LONGITUDINAL AERODYNAMICS OF A HIGH-LIFT–DRAG-RATIO WING-BODY CONFIGURATION AT MACH 6.0

David R. Stone and George C. Ashby, Jr. Washington Mar. 1968 30 p refs

(NASA-TN-D-4361) CFSTI: HC $3.00/MF $0.65 CSCL 01A

An aerodynamic investigation of the addition of volume to the leeward surface of a basic high-wing configuration has been made with volume additions varying from 9 percent to 92 percent of the basic wing-body volume. The free-stream Reynolds number based on body length was 9.5×10^6. For a given volume addition, the experimental results show that span-height ratio, cross-sectional shape, and longitudinal contour had only secondary effects on the maximum lift–drag ratio. Calculations using shock theory indicate the effects of these parameters are overshadowed by the interaction between the volume-addition shock and the wing-body shock. The results indicate that a practical design practice would be to place the forebody volume addition at the wing apex, and the amount of afterbody volume added would thus be limited by the center-of-gravity location and the associated pitch characteristics of the vehicle. For a constant afterbody length, the maximum lift–drag-ratio variation with volume addition was found to be correlated by the parameter comprised of the product of the forebody slope and the percent volume added. Author

N68-17896*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

PRESSURE DISTRIBUTIONS AND AERODYNAMIC CHARACTERISTICS OF 90° AND 15° BLUNTED CONES IN NITROGEN AND HELIUM AT MACH 20

Theodore R. Creel, Jr., Charles G. Miller, III, Dal V. Maddalon, and Ralph D. Watson Washington Mar. 1968 37 p refs

(NASA-TN-D-4314) CFSTI: HC $3.00/MF $0.65 CSCL 01A

An experimental investigation to determine the pressure distributions and force and moment characteristics on a 9° semiapex angle spherically blunted cone was conducted in nitrogen in the Langley hotshot tunnel. Pressure distributions were obtained in the Langley 22-inch helium tunnel on 9° semiapex angle spherically blunted and flat-faced cones and on a 15° semiapex angle spherically blunted cone. The results of this investigation indicated that pressure distributions on the 9° and 15° semiapex angle spherically blunted cones at zero angle of attack were underpredicted by ideal gas inviscid theory, but a theory accounting for viscous effects predicted the pressure distribution on the 9° spherically blunted cone in nitrogen. Blast-wave-type correlation parameters were observed to yield a fair correlation of pressure distributions obtained on the most windward meridian for angles of attack of 5° to 40° when an effective cone angle was used. Newtonian theory adequately predicted the radial pressure distributions on the windward side of the 9° and 15° semiapex angle spherically blunted cones. The shock shapes of the 9° and 15° cones were correlated by using blast-wave-type correlating parameters. Force and moment coefficients for the 9° spherically blunted cone in nitrogen were in good agreement with those of other investigations using air and nitrogen as test gases. Author

N68-17899*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

A REAL-GAS STUDY OF LOW-DENSITY WEDGE-INDUCED LAMINAR SEPARATION ON A HIGHLY COOLED BLUNT FLAT PLATE AT $M_\infty = 12$

John B. Anders and C. L. W. Edwards Washington Mar. 1968 40 p refs

(NASA-TN-D-4320) CFSTI: HC $3.00/MF $0.65 CSCL 01A

A study has been made of real-gas wedge-induced laminar separation. A series of experimental tests on a blunt flat plate with

a trailing-edge flap was made at a free-stream Mach number of 12 and a free-stream Reynolds number of 10^4/ft (3.3×10^4/m). The tests were conducted for stagnation enthalpies ranging from 1465 Btu/lbm (3.41 MJ/kg) to 2030 Btu/lbm (4.73 MJ/kg). A calculation technique is developed to predict the chordwise extent of wedge-induced laminar separation and agrees reasonably well with the present real-gas experimental data. The computed effect of free-stream Reynolds number and total enthalpy on the extent of separation is demonstrated. Sample calculations are shown for equilibrium and frozen flow for a range of total enthalpies. Author

N68-17900*# Scripta Technica, Inc., Washington, D. C.
SUPERSONIC FLOWS AROUND CONES AT INCIDENCE [ECOULEMENTS SUPERSONIQUES AUTOUR DE CONES EN INCIDENCE]
Rene Gonidou Washington NASA Jan. 1968 15 p refs Transl. into ENGLISH from French Repts.
(Contract NASw-1694)
(NASA-TT-F-11473) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Presented are some numerical results obtained at Mach 7 for the supersonic flow of a perfect gas around conical bodies (or circular or elliptical cross sections) at incidence. This study shows that the shock wave remains closed for angles of incidence greater than the half-aperture angle of the circular cone. Starting with a certain incidence, the singular point of entropy located on the upper surface moves from the surface of the body toward the interior of the flow. Numerical instabilities then appear which make it impossible to continue the study up to higher angles of incidence where the shock becomes evanescent. Author

N68-17917# Aerospace Corp., El Segundo, Calif.
A NOTE ON THE DRAG COEFFICIENT EVALUATION FOR CONICAL VEHICLES IN THE LOW-DENSITY TRANSITIONAL FLOW REGIME
Charles R. Ortloff Oct. 1967 18 p
(Contract F04695-67-C-0158)
(TR-0158(3240-20)-3; SAMSO-TR-67-123; AD-663421)

A general expression for the drag coefficient for a slender conical vehicle moving at hypersonic velocity in the low density transitional flow regime is obtained in this note. The method of calculation of C sub D follows from Rosens variational method of solution of the Boltzmann equation previously reported by the author in the literature. The theoretically predicted drag coefficient from the variational method is given in the Knudsen number range $.01 < Kn < 100$. Results are compared to existing continuum, viscous interaction, near free molecule, and free molecule theories in the regions where predictions of these theories overlap results obtained from the variational method. Author (TAB)

N68-18033# National Aerospace Lab., Tokyo (Japan).
STREAMLINE CURVATURE APPROACH TO DUCT-FLOW PROBLEMS
Shoichi Fujii and Takenobu Uno 1967 23 p refs
(NAL-TR-140) CFSTI: HC$3.00/MF$0.65

This paper is principally in connection with a work on the front-fan, the design of which freqeuntly requires a powerful method of calculation. The streamline-curvature technique has been effectively applied by using a modern digital computer. In this method, the procedure of fitting a curve through the points defining each streamline will be of engineering importance. Hence, two methods by spline-fit and least-squares curves were investigated in detail, with the result that the approximate nature of spline-fit was not always amenable to solution on the digital computer. On the other hand, the lease-squares curves with fifth or sixth order terms were successfully used in the actual design problem. A comparison between the streamline curvature method and the exact solution was also made for the incompressible flow around a point source in an infinitely long duct of constant diameter. Author

N68-18119*# Techtran Corp., Glen Burnie, Md.
USE OF ELECTRONIC COMPUTERS FOR DETERMINATION OF THE AERODYNAMIC CHARACTERISTICS OF AIRCRAFT [ISPOL'ZOVANIYE ELEKTRONNO-SCHETNYKH MASHIN DLYA OPREDELENIYA AERODINAMICHESKIKH KHARAK-TERISTIK LETATEL'NYKH APPRARATOV]
O. M. Belotserkovskiy Washington NASA Feb. 1968 6 p refs Transl. into ENGLISH from Russian Presented at 18th Congr. of Intern. Astronautical Federation, Belgrade, 25–30 Sep. 1967
(Contract NASw-1695)
(NASA-TT-F-11564) CFSTI: HC$3.00/MF$0.65 CSCL 01A

If a problem is formulated correctly mathematically and a numerical algorithm for its solution by electronic computer can be developed, considerably more and considerably less expensive information can be produced than by experimental methods. The flow about a blunt aerodynamic form with a break in the generatrix is analyzed as an example of this. Cones are analyzed with various half aperture angles (5, 0 and 10°) and with an oncoming stream moving at Mach 4. The intensity of the "hanging" compression discontinuity first increases sharply, then gradually decreases with increasing distance from the blunt nose. Author

N68-18134# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany).
FLOW INVESTIGATIONS AROUND SWEPT COMPRESSOR CASCADES AT COMPRESSIBLE SUBSONIC FLOW
Udo Stark 13 Jun. 1966 97 p refs
(DFL-0331; Rept.-65143)

Axial flow turbomachines often have nose cones and stator housings which are conically shaped. As a consequence, therefore, the assumed radially installed blading is no longer subjected to flow normal to the blade leading edges, but the flow approaches the blading under a certain sweep angle. For the single blade, the aerodynamic effect of sweep has long been known at high subsonic and transonic Mach numbers. In this report the aerodynamic characteristics of swept compressor blading cascades is investigated over the range of high subsonic speeds. For this purpose loss coefficients, flow turning, and pressure rise in the pitch sections of the cascade have been measured for one straight and two swept compressor blade cascades with sweep angles ($\phi = 20°$, $\phi = 40°$) using a high velocity cascade wind tunnel. These wake measurements show the principle effect of sweep which is a decrease of turning and pressure rise and an increase of the critical Mach number. Pressure distribution measurements in several parallel wall sections showed a considerable effect of the side wall upon the aerodynamic characteristics of the blade cascades. Author

N68-18138*# Techtran Corp., Glen Burnie, Md.
ARTIFICIAL INITIATION OF THE SUPERSONIC TRANSITION [DECLENCHEMENT ARTIFICIEL DE LA TRANSITION EN SUPERSONIQUE]
Xavier Vaucheret Washington NASA Feb. 1968 15 p refs Transl. into ENGLISH from Rech. Aerospatiale (France), no. 120, 1967 p 25–32
(Contract NASw-1695)
(NASA-TT-F-11558) CFSTI: HC$3.00/MF$0.65 CSCL 01A

Following a comparison of the criteria proposed by various authors for defining the height of roughnesses necessary to initiate transition in supersonic flow, the results obtained in the S-2 wind tunnel during a preliminary study for industrial tests are described. A choice of the criteria allowing a definition of the location and of the height of the critical roughnesses initiating transition without giving any additional drag is proposed. An examination of this additive drag leads, in the case of industrial tests, to an appropriation of the artificial initiation of transition as a function of the precision required in the determination of the cruise-flight drag from wind-tunnel tests. Author

N68-18189*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
WIND TUNNEL INVESTIGATION OF TECHNIQUES FOR REDUCING COWL DRAG OF AN AXISYMMETRIC EXTERNAL-COMPRESSION INLET AT MACH 2.49
James E. Calogeras and Edward T. Meleason. Washington Mar. 1968 33 p refs
(NASA-TM-X-1516) CFSTI: HC$3.00/MF$0.65 CSCL 01A

A wind-tunnel investigation was made at Mach 2.49 to determine the effectiveness of two techniques for cowl-drag reduction on an axisymmetric external-compression inlet. The first method involved reducing the external cowl-lip angle from 25° to values of 15° and 6°. Use of the flatter cowls deliberately violated the criterion for internal cowl-lip shock attachment to affect a tradeoff between cowl pressure drag and induced additive drag. Results showed an increase in external drag over that associated with the 25° cowl, and inlet performance was significantly reduced with use of the flatter cowls. The second method used a low-external-angle visor with the 25° cowl. An air gap existed between the cowl and the visor base to aid in starting the inlet, and several gap sizes were investigated. With the smallest air gap tested, external drag was reduced by 54 percent with only a small loss in performance. With a larger air gap sized to permit self-start at Mach 2.5, external drag was reduced by 35 percent; this reduction, however, was accompanied by some loss in overall inlet performance associated with flow expansion into the visor gap.
Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N68-17270# Royal Aircraft Establishment, Farnborough (England).
A PILOTED SIMULATOR STUDY OF THE TAKE-OFF MANOEUVRE OF A LARGE AIRCRAFT WITH AND WITHOUT A TAKE-OFF DIRECTOR
C. O. O'Leary and D. H. Perry Aug. 1966 69 p refs
(RAE-TR-66244)

A piloted simulation of the take-off maneuver of a large aircraft has been developed to aid research into take-off director instruments. Records of undirected take-offs made in real flight and on the simulator have been compared, and these, as well as pilot's subjective opinions, show that the simulation was adequate for its purpose. The need for cockpit motion and visual simulation was studied briefly. Tests with one suggested form of take-off director showed that take-offs with the director were more consistent, and had increased margins of safety, compared with undirected take-offs.
Author

N68-17391*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A PILOTED SIMULATOR STUDY OF TAKEOFF PERFORMANCE AND HANDLING QUALITIES OF A DOUBLE DELTA SUPERSONIC TRANSPORT
C. Thomas Snyder and Charles T. Jackson, Jr. Washington Feb. 1968 49 p refs
(NASA-TN-D-4396) CFSTI: HC$3.00/MF$0.65 CSCL 14B

The takeoff characteristics of a generalized double-delta supersonic transport configuration were investigated in a fixed-cockpit simulator equipped with an external visual display. The objectives were to investigate performance and handling qualities, identify possible problem areas, and assist in the evaluation of certification requirements to be used during the development of the SST. The unaugmented SST exhibited: (1) excellent performance during normal takeoffs, (2) a greater probability of nacelle or tail scrapes than the SJT, indicating a need for more time for the rotation maneuver, a longer landing gear on the design tested, or higher lift-off speeds, (3) initial climb characteristics which were acceptable but unpleasant, due to a tendency toward pitch "wandering," aggravated by negative speed-drag stability, (4) good lateral-directional and engine-out characteristics, and (5) a performance sensitivity to lift-off speed abuse during marginal-thrust takeoffs, which indicated the need for review of the present airworthiness criterion regarding one-engine-inoperative first-segment climb.
Author

N68-17439# Advisory Group for Aerospace Research and Development, Paris (France).
STABILITY AND CONTROL, PART 1
London Tech. Editing and Reprod., Ltd. Sep. 1966 508 p refs Presented at the AGARD Flight Mech. Panel Specialists' Meeting, Cambridge, England, 20–23 Sep. 1966
(AGARD-CP-17, Pt. 1) CFSTI: HC$3.00/MF$0.65

Conference papers are presented pertaining to dynamic motions of aircraft, general handling criteria, autostability and control, and methods of determining stability and control data. For individual titles, see N68-17440 through N68-17459.

N68-17440# Boeing Co., Seattle, Wash.
DYNAMIC MOTIONS OF AIRCRAFT—SURVEY AND INTRODUCTION
Clarence C. Flora *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 1–20 refs (See N68-17439 08-02)

Unresolved problems in the field of dynamic stability and related flight handling characteristics which are posed by mass and inertial properties of future transport aircraft are discussed. Analyzed are problems related to low speed control response; the dynamics of longitudinal control and flight path response; and high speed control response and aeroelasticity. It is concluded that: (1) Adequate low speed longitudinal control of the flight path of large slender aircraft may require unconventional means that will allow vertical acceleration to be controlled without the filtering action of the airframe pitch dynamics. (2) Development of these control means will require careful integration of the aerodynamic, structural, and actuation system design to achieve the flight dynamics benefits with acceptable weight, complexity, and reliability. (3) Low speed lateral directional response will be characterized by large roll sideslip coupling, and achievement of acceptable flying qualities will require careful consideration of the turn entry and steady turn rudder requirements, as well as the usual considerations of dutch roll mode characteristics and bank angle aileron transfer function pole-zero relationship. (4) High speed longitudinal response will be significantly affected by the oscillatory elastic response of the airframe, and interaction of the elastic response characteristics with the SAS will be a limiting factor in the degree of augmentation possible in the rigid body response of the airplane.
S.C.W.

N68-17441# Royal Aircraft Establishment, Bedford (England).
SOME OBSERVATIONS ON THE DYNAMICS OF LARGE SLENDER AIRCRAFT
W. J. G. Pinsker *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 21–51 refs (See N68-17439 08-02)

Discussed are selected control factors and their effects on large slender design aircraft dynamics and flying characteristics. General flight experience on small slender research aircraft and the limited applicability of current handling criteria to this class of vehicle is discussed; and areas in which the controllability of the slender aircraft shows characteristics not normally met on more

conventional configurations are analyzed. Considered are the following factors: mode coupling due to inertia imbalance; ground clearance at and after liftoff; cross wind approach; and recovery from upset by tail gust in the approach. Inertia cross coupling is shown to lead in some cases to large peaks in normal acceleration in rudder induced maneuvers and it is concluded that it may be necessary to restrict the rudder power which the designer is allowed to make available to the pilot. Liftoff is studied as a dynamic process, with the result that the critical condition for ground clearance is found to exist one to two seconds after liftoff and that this tends to become more severe the larger and more slender the aircraft. Tail gust in the approach is shown to become a severe test of an aircrafts longitudinal controllability and it becomes more difficult as aircraft size increases, to provide adequate control for the pilot to prevent hard landings in severe atmospheric conditions. On the basis of these findings it is surmised that control by elevator may have to be assisted by some form of direct lift control. In the highly powered aircraft, use of thrust for longitudinal control showed promise as a relatively straightforward solution. S.C.W.

N68-17442# Aeronautical Research Associates of Princeton, Inc., N. J.

DEVELOPMENTS IN AEROELASTICITY FOR LARGE AIRCRAFT

John C. Houbolt *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 55–78 refs (See N68-17439 08-02)

Reviewed are recent developments and trends in aeroelastic considerations of large fixed wing aircraft. Evaluated are problems related to static aeroelasticity; self-induced aeroelastic phenomena such as flutter, buzz, and buffet; aircraft gust encounter; and substandard landing sites. S.C.W.

N68-17443# London Univ. (England).

THE ROLE OF FLUTTER DERIVATIVES IN AIRCRAFT STABILITY AND CONTROL

R. D. Milne *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 79–98 refs (See N68-17439 08-02)

Described is a method for solving problems of transient motion of aero-mechanical systems. The proposed method uses flutter derivatives as basic data and expresses the solution to aero-mechanical equations of motion largely in terms of exponentials. Major limitations of the method are that the solution does not apply for very short intervals of time after the application of impulsive forces to the system. The use of constant derivatives as in aircraft stability and control and the familiar simple harmonic flutter type of solution are both included as special cases. Emphasized is the applicability of the proposed method in flutter analyses. Cited is an unpublished paper which contains mathematical details involved in the asymptotic solution of linear, stationary, integro-differential equations for flutter analysis. S.C.W.

N68-17444# North American Aviation, Inc., Los Angeles, Calif.

COMPARISON OF COMPUTER AND FLIGHT TEST RESULTS FOR A SPINNING AIRPLANE

John H. Wykes and Gilbert R. Casteel *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 101–125 refs (See N68-17439 08-02)

A study designed to analytically determine the complete spinning characteristics (spin entry, steady spin, and recovery) of an airplane is reported. The study was based on the assumption that a spinning airplane may be described in the same manner as a rolling airplane. To determine the validity of the proposed assumption, the following were pursued: (1) Existing flight test data obtained during spin demonstration flights of the F-100D were analyzed to obtain data on the mechanics of spin. (2) A low speed wind tunnel test of the F-100D through spin angles of attack and sideslip was made to obtain static aerodynamic stability and control data. (3) A technique for using static aerodynamic data to obtain the rotary derivatives was developed. Using results from the above studies, a series of spin calculation were made using digital computer methods. Results of these calculations were compared with flight test data. Results indicate that it is feasible to calculate the spin characteristics of an airplane, from incipient spin through recovery phases, using static aerodynamic wind tunnel data and estimated rotary derivatives based on these static test data. It is further shown that the proposed method of calculation enables the study (systematically) of the effects of several important variables influencing aircraft spin response and in doing so serves to prevent expensive redesign in later phases. S.C.W.

N68-17445# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

ANALYTICAL STUDY OF SPIN [ETUDE ANALYTIQUE DE LA VRILLE]

Michel Scherer and Marie-Odile Aguesse *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 127–158 refs In FRENCH (See N68-17439 08-02)

Results obtained during the first phase of an analytical study to find a method for calculating spin are in agreement with measures made on a model in free spin in a vertical wind tunnel; and the proposed method is considered applicable for calculations with measures obtained during the flight of actual aircraft. Calculations are presented for the spin of a small delta aircraft model; and the uncertainties associated with scale effect and inertia constants were eliminated in these studies in a horizontal wind tunnel. Two configurations were investigated; one of spin stabilization and the other of escaping spin. Analytical results, calculations, and applications are detailed; including analytical measurements in forced rotation. Transl. by M.W.R.

N68-17447# Air Force Systems Command, Wright-Patterson AFB, Ohio.

FLYING QUALITIES CRITERIA PROBLEMS AND SOME PROPOSED SOLUTIONS

John W. Carlson and Richard K. Wilson *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 177–210 refs (See N68-17439 08-02)

The purpose of this paper is to discuss some of the shortcomings of current flying qualities criteria, and describe the program the United States Air Force is presently pursuing to revise and update or otherwise replace these criteria. The results of recent research investigations are reviewed and some promising flying qualities parameters which were identified during these programs are discussed. Several existing or developmental aircraft are compared with existing handling qualities requirements and some suggested criteria, and potentially useful new criteria are examined. Author

N68-17448# National Aeronautical Establishment, Ottawa (Ontario).

SOME PROBLEMS IN CONTROL ARISING FROM OPERATIONAL EXPERIENCES WITH JET TRANSPORTS

B. Caiger *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 211–226 refs (See N68-17439 08-02)

Jet transport control problems arising from incidents in which the aircraft is disturbed from its intended flight path upon encountering turbulence under instrument flight conditions, and those arising from pilot misinterpretation of flight instrument data in turbulence and limitations of the pitch control systems are discussed. Evaluated are selected aspects of jet transport upsets which were studied during a major accident investigation. On the basis of these studies, it is concluded that: (1) Vibration levels at the flight deck during severe turbulence encounters should be studied on future aircraft. (2) The potential benefits of head-up displays in enabling the pilot to acquire flight instrument information during vibration should be considered. (3) Flight measurements of pilot control inputs in severe turbulence should be analyzed in

order to obtain a better understanding of typical responses, and the contribution of any related disorientation effects should be studied. (4) The design dive speed requirements for jet transports should be made more severe, and care should be taken to ensure that adequate primary pitch control is available without reliance on trim devices. S.C.W.

N68-17449# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
A REVISED PILOT RATING SCALE FOR THE EVALUATION OF HANDLING QUALITIES
Robert P. Harper, Jr. and George E. Cooper (NASA. Ames Res. Center) *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 227–245 refs (See N68-17439 08-02)

Described is an improved pilot rating scale for the evaluation of aircraft handling qualities. Included is a critical review of existing method of handling qualities assessment; a review of the use of rating scales in general; and an attempt to clarify the concepts and procedures used in any pilot evaluation. S.C.W.

N68-17450# Massachusetts Inst. of Tech., Cambridge. Instrumentation Lab.
OPTIMIZATION OF THE USE OF AUTOMATIC FLIGHT CONTROL SYSTEMS FOR MANNED AIRCRAFT
H. Philip Whitaker and James E. Potter *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 255–276 refs (See N68-17439 08-02)

A study designed to determine whether automatic control systems should be used to control aeronautical vehicles, and whether satisfactory systems can be synthesized is reported. Considered in the evaluation are the following: automatic control system synthesis, modern control theory synthesis, and synthesis using model reference adaptive control methods. It is concluded: (1) The most successful use of automatic control subsystems for flight vehicles will result when the decision to employ them is based upon sound engineering evaluations of the technical factors involved rather than upon subjective preconceptions. (2) The methods of modern control theory which have been made possible through the availability of high speed computers can be used to synthesize these systems; however, these methods are handicapped by the difficulty of expressing operational engineering requirements in the mathematical terminology that these methods require. (3) Mechanical mathematical manipulations may result in an unfortunate masking of the physical relationships that exist in the operational system which may actually hinder rather than help the design effort and yield greater complexity than is necessary. (4) An alternative procedure that permits investigations of simple system configurations with realistic constraints is to use an adaptive control system as a synthesis tool. (5) If the complete state vector is assumed to be available, then both methods can be made to give identical results. S.C.W.

N68-17451# Elliott Bros., Ltd., London (England).
THE DESIGN OF AUTOSTABILISERS WITH PARTICULAR REFERENCE TO LOW SPEED HANDLING AND GROUND ATTACK OPERATIONS
G. Belcher *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 277–309 refs (See N68-17439 08-02)

Techniques used in the design of modern stability augmentation systems are described. It is shown that artificial stabilization is a powerful tool in improving the aircraft response to give better handling qualities demanded by the specification, even when other considerations make the basic aircraft response far from ideal. The techniques considered include transient response, root locus, frequency response, and spectral density together with cockpit simulators. These techniques are used by the system designer to assess design effectiveness, and these techniques also deal efficiently with structural coupling problems and some of the nonlinearities which occur in aircraft systems. It is shown that when performance or weight requirements force the aircraft designer to produce an airframe with less than adequate handling characteristics, the autostabilizer can augment the basic aircraft controls to provide good pilot ratings. S.C.W.

N68-17452# Sud-Aviation, Paris (France).
PROBLEMS POSED BY THE INTEGRATION OF A SYSTEM OF AUTOMATIC FLIGHT CONTROL IN THE COMMAND OF FLIGHT OF AN AIRPLANE AT HIGH PERFORMANCES. EXAMPLE OF APPLICATION IN THE FRAMEWORK OF THE PROJECT OF CIVIL SUPERSONIC CONCORDE TRANSPORT [PROBLEMES POSES PAR L'INTEGRATION DU SYSTEME DE CONTROLE AUTOMATIQUE DE VOL DANS LES COMMANDES DE VOL D'UN AVION A HAUTES PERFORMANCES. EXEMPLE D'APPLICATION DANS LE CADRE DU PROJET DE TRANSPORT CIVIL SUPERSONIQUE "CONCORDE"]
R. Deque *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 311–326 refs In FRENCH (See N68-17439 08-02)

Base-line flight qualities and planned missions for a civil supersonic transport were studied within the framework of automatic command control for the Concorde transport, along with the requirements of materials for the automatic piloting aids. In terms of these requirements and the characteristics of the aircraft and the conditions for its use, it was necessary to choose the best automatic flight control system. Redundancy and safety measures were considered, and interfaces between the automatic control and associated systems were investigated. Transl. by M.W.R.

N68-17453# British Aircraft Corp., Preston (England).
AUTO-AEROELASTIC MODE COUPLING, A COMPARISON OF PREDICTED AND ACTUAL CHARACTERISTICS
G. J. Evans and B. J. Beele *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 331–359 refs (See N68-17439 08-02)

Results of theoretical and experimental studies designed to check and define requirements for high performance aircraft stability augmentation and maneuver control systems are reported. Emphasized is the need for meeting both low and high frequency performance requirements simultaneously during the early design stages of aircraft. It is concluded that: (1) Theoretical studies employing linearized mathematical models of the system are valuable in highlighting the extent of potential problem areas. (2) In deriving mathematical models of the airframe for automatic flight control system oriented studies, a much improved theoretical representation of the fuselage is essential. (3) It is important to plan experimental tests so that information for the mathematical model becomes available at an early date. (4) Preflight tests of the complete system, including airframe, are of immense value. (5) A knowledge of automatic flight control system stability margins is essential before it can be confidently predicted that small changes in the values of system parameters will not result in an unstable situation. (6) The most direct method of acquiring the required information on stability margins is by direct open or closed loop frequency response testing through the actuator system. (7) The application of cross correlation methods promises several advantages, particularly when based on Pseudo Random Binary Noise techniques. (8) Future resonance and flutter testing requirements should be integrated as far as possible with those of the automatic flight control system clearance program. S.C.W.

N68-17454# Air Force Systems Command, Wright-Patterson AFB, Ohio.
CONTROL OF FLEXIBLE AIRCRAFT DYNAMIC RESPONSE
H. Max Davis and Robert L. Swaim *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 361–390 refs (See N68-17439 08-02)

A critical analysis of gust response control research is presented which indicates the need for improved aircraft gust response characteristics. Factors which are important to the success of gust response control are considered, and some of the capabilities still needed for gust response control systems are described. Included are examples which illustrate the need for reducing critical gust response at subsonic speeds. Considered in the analysis are criteria for gust response control, basic principles used in gust response control, critical stability problems related to mode coupling through the control system, and control force generation. Requirements for further technical development are also discussed. It is concluded that: (1) Substantial improvements in fatigue life, riding qualities and peak loads, as well as reductions in the probability of losing control in extreme turbulence are required. (2) The designer has several alternative approaches to achieve his design goals involving a variety of components and system concepts; however, none of these approaches change the complex multi-loop, multi-variable design problem. (3) Closely coupled loops required detailed attention and the use of modern computer equipment. (4) Expense is one of the major factors affecting the adoption of gust response control; and improvements in design procedures, namely better design criteria, more accurate aerodynamic techniques and optimal control design, are expected to improve the design confidence and lower costs. S.C.W.

N68-17455*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE SIGNIFICANCE OF NONLINEAR DAMPING TRENDS DETERMINED FOR CURRENT AIRCRAFT CONFIGURATIONS

Harleth G. Wiley *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 393–408 refs (See N68-17439 08-02) CSCL 01C

Basic principles and features of a rigidly forced oscillatory dynamic stability technique for measuring pitch and yaw damping derivatives in wind tunnels at transonic and supersonic speeds are described. A discussion of string effects on the measured parameters is included. A broad range of aircraft configurations was studied. Both fixed wing and variable sweep proposals, suitable for supersonic military and transport use, were studied at subsonic, transonic, and supersonic speeds. Extensive experiments were also made on the effects of angle of attack on the damping characteristics of typical contemporary swept wing jet transport configurations at subsonic and transonic speeds. Selected results from these experimental studies are discussed and the significance of these damping trends to the flight response (i.e., stall entry and recovery) of a representative aircraft type, as determined by analytical and simulator studies, is analyzed. S.C.W.

N68-17457# Royal Aircraft Establishment, Bedford (England).

OSCILLATORY DERIVATIVE MEASUREMENTS ON STRING-MOUNTED WIND TUNNEL MODELS AT RAE, BEDFORD

J. S. Thompson and R. A. Fail *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 437–470 refs (See N68-17439 08-02)

Equipment for measuring oscillatory derivatives is described. The equipment consists of a three degrees of freedom rig for tests in yaw, roll, and sideslip. A feature of the rig is that all the mechanical parts are mounted on a standard string and form a self contained unit which can easily be installed in different wind tunnels. Also the spring unit is designed so that realistic values of the frequency parameter are obtained without recourse to specially light weight model construction. A set of derivatives measured at low speed were made during the development of the rig, and results indicate that satisfactory measurements can be made of all derivatives at low speeds. Also during developmental phases, tests were made on a 1/8th scale model of the HP 115 (experimental delta wing aircraft). Tests were made in a 13 ft×9 ft wind tunnel at a wind speed of 200 ft/sec and frequencies of about 3.4 c/s in the yawing mode, 5.7 c/s in sideslip, and 13.5 c/s in roll. Derivatives were referred to an axis at 58% of the center-line chord. Results of these tests are included to demonstrate the accuracy and reliability of the system. S.C.W.

N68-17459# Technische Hogeschool, Delft (Netherlands).

DETERMINATION OF PERFORMANCE, STABILITY AND CONTROL CHARACTERISTICS FROM MEASUREMENTS IN NON-STEADY MANOEUVRES

O. H. Gerlach *In* AGARD Stability and Control, Pt. 1 Sep. 1966 p 497–523 refs (See N68-17439 08-02)

The status of research focusing on the development of a flight test method for determining performance, and stability and control characteristics during nonsteady maneuvers is reported. The method combines the features of response measurements with those of determining aircraft drag characteristics using the accelerometer method. Aircraft characteristics to be determined from measurements in nonsteady flight include: rate of climb in steady flight as a function of airspeed; polar curve (C_D vs. C_L); elevator angle to trim in steady flight as a function of airspeed; stick displacement per g in maneuvering flight; positions of neutral point and maneuver point (stick fixed); and longitudinal stability derivatives including those with respect to change of airspeed. A discussion of the method of regression analysis on which the flight test method largely depends is presented. S.C.W.

N68-17460# Advisory Group for Aerospace Research and Development, Paris (France).

STABILITY AND CONTROL, PART 2

London Tech. Editing and Reprod., Ltd. Sep. 1966 474 p refs Presented at the AGARD Flight Mech. Panel Specialists' Meeting, Cambridge, England, 20–23 Sep. 1966
(AGARD-CP-17, Pt. 2) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. COMPARISON OF MEASUREMENTS AND ESTIMATES FOR MOMENTS OF INERTIA OF AIRCRAFT R. Rose (Royal Aircraft Establish.) p 525–538 (See N68-17461 08-02)

2. METHOD FOR DETERMINING MOMENTS OF INERTIA USING GRAND VIBRATION TESTS R. Kappus (Office Natl. d'Etudes et de Recherches Aeron.) p 539–547 ref (See N68-17462 08-02)

3. FLIGHT SIMULATION—SOME ASPECTS OF ITS USE FOR STUDIES OF AIRCRAFT HANDLING QUALITIES D. H. Perry (Royal Aircraft Establish.) p 553–576 refs (See N68-17463 08-02)

4. RECENT EXPERIENCE WITH IN-FLIGHT SIMULATION W. O. Breuhaus (Cornell Aeron. Lab.) p 577–620 refs (See N68-17464 08-02)

5. HANDLING QUALITIES AND PILOT WORKLOAD C. B. Westbrook, R. O. Anderson, and P. E. Pietrzak (AFSC) p 625–648 refs (See N68-17465 08-05)

6. PHYSIOLOGICAL AND PSYCHOLOGICAL MEASUREMENTS OF PILOT WORKLOAD F. G. Cumming and K. G. Corkindale (Royal Air Force) p 649–657 refs (See N68-17466 08-04)

7. EFFECTS OF TASK VARIABLES ON PILOT MODELS FOR MANUALLY CONTROLLED VEHICLES D. T. McRuer and H. R. Jex (Sys. Tech. Ind.) p 659–701 refs (See N68-17467 08-05)

8. PILOT INDUCED INSTABILITY R. C. A'Harrah and R. F. Siewert (No. Am. Aviation) p 703–722 refs (See N68-17468 08-05)

9. A STUDY OF THE LONGITUDINAL BEHAVIOUR OF AN AIRCRAFT AT NEAR-STALL AND POST-STALL CONDITIONS H. H. B. M. Thomas (Royal Aircraft Establish.) p 729–769 refs (See N68-17469 08-02)

10. STABILITY AND CONTROL ANALYSIS OF AN AIRPLANE BEYOND ITS MAXIMAL LIFT Ph. Poisson-Quinton AND E. Erlich (Office Natl. d'Etudes et de Recherches Aeron.) p 771–792 refs (See N68-17470 08-02)

11. THEORETICAL CONSIDERATIONS. WIND-TUNNEL RESEARCH AND FLIGHT-TEST RESULTS ON THE SUPPER-STALL CHARACTERISTICS OF THE HFB 320 HANSA H. Wocke (Hamburger Flugzeugbau G.m.b.H.) p 793-808 (See N68-17471 08-02)

12. FACTORS AFFECTING PILOT LANDING TECHNIQUES K. J. Dyda and N. M. Lefritz (No. Am. Aviation) p 813-830 refs (See N68-17472 08-05)

13. THE EFFECT OF LOW ALTITUDE GUSTS ON AUTOMATIC LANDING J. C. Hall (Hawker Siddeley Aviation) p 831-853 refs (See N68-17473 08-02)

14. A FEW NOTES ON THE PROBLEM OF SPEED STABILITY J. Buhrman, F. E. Douwes Dekker, and C. M. Kalkman (Natl. Lucht-en Ruimtevaartlaboratorium) p 855-870 refs (See N68-17474 08-02)

15. MIXED PILOT AND AUTOMATIC LONGITUDINAL CONTROL DURING LANDING APPROACH R. Brockhaus (Deutsche Forschungsanstalt fur Luft- und und Raumfahrt) p 871-902 refs (See N68-17475 08-02)

16. A STATISTICAL MODEL OF ATOMSPHERIC TURBULENCE AND A REVIEW OF THE ASSUMPTIONS NECESSARY FOR ITS USE F. E. Pritchard (Cornell Aeron. Lab.) p 907-936 refs (See N68-17476 08-20)

17. NASA RESEARCH EXPERIENCE ON JET AIRCRAFT CONTROL PROBLEMS IN SEVERE TURBULENCE R. J. Wasicko (NASA) p 937-955 refs (See N68-17477 08-02)

18. COCKPIT DISPLAYS D. J. Walters (Royal Aircraft Establish.) p 957-977 (See N68-17478 08-02)

19. OPERATIONAL EXPERIENCE AT MACH 3 A. S. White and P. H. Anderson (No. Am. Aviation) p 979-993 (See N68-17479 08-02)

N68-17461# Royal Aircraft Establishment, Bedford (England).
COMPARISON OF MEASUREMENTS AND ESTIMATES FOR MOMENTS OF INERTIA OF AIRCRAFT
R. Rose *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 525-538 (See N68-17460 08-02)

The extraction of stability derivatives from dynamic flight tests requires a knowledge of the moments of inertia of the aircraft and of the inclination of the principal inertia axis. Inertia characteristics can be either estimated or measured. The test techniques used in measuring moments of inertia are briefly described. These techniques require that the aircraft be supported on knife edges or suspended by cables. These techniques may not be possible for large aircraft, particularly in the case of yawing moment of inertia measurements. Measured and estimated inertia data for various aircraft with and without fuel are compared. At the present, measurements have not been made on a sufficient number of aircraft to establish with confidence whether current methods of estimating moments of inertia of aircraft and fuel are satisfactory or not. From the limited evidence available it can be tentatively concluded that current methods of estimation appear to be reasonably accurate. R.N.A.

N68-17462# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
METHOD FOR DETERMINING MOMENTS OF INERTIA USING GRAND VIBRATION TESTS [METHODE DE DETERMINATION DES CONSTANTES D'INERTIE A L'AIDE D'UN ESSAI DE VIBRATION AU SOL]
Robert Kappus *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 539-547 ref. In FRENCH (See N68-17460 08-02)

A general method is proposed for determining the moments of inertia of any aircraft, engine, or body. It is not necessary that the body be symmetrical, nor that it be indeformable when subjected to vibrations with relatively low frequencies. The model is elastically suspended in a manner suitable for returning the elastic in several directions, due to excitation by harmonic vibrations with small amplitudes. It is necessary that the suspension be sufficiently linear, strong, and as flexible as possible. Six modes are listed for the ground vibration tests, and several examples of rigid and flexible model tests are discussed to illustrate the technique. Transl. by M.G.J.

N68-17463# Royal Aircraft Establishment, Bedford (England).
FLIGHT SIMULATION—SOME ASPECTS OF ITS USE FOR STUDIES OF AIRCRAFT HANDLING QUALITIES
D. H. Perry *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 553-576 refs (See N68-17460 08-02)

A ground based flight simulation facility is described which has been used in aircraft handling qualities studies, particularly in the fields of takeoff, approach, and landing for fixed wing aircraft, and of hovering and transition maneuvers for jet lift VTOL aircraft. After a brief description of the equipment, the problems of validating the simulation and some examples of research studies made on the simulator are discussed. A general philosophy for the use of simulation in handling qualities studies, based on the experience gained during these studies, is discussed. R.N.A.

N68-17464# Cornell Aeronautical Lab., Inc., Buffalo, N. Y. Flight Research Lab.
RECENT EXPERIENCE WITH IN-FLIGHT SIMULATION
Waldemar O. Breuhaus *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 577-620 refs (See N68-17460 08-02)

The early history of in-flight simulation is briefly reviewed. Consideration is then given to the validity of simulation techniques, including simulation with no motion, simulation with correct translational acceleration, simulation with correct angular acceleration, visual simulation with no motion, and visual simulation with limited motion. The results of several recent in-flight simulation programs are described. These include the investigation of drag-curve shaping during the landing approach for the fighter-type and supersonic transport class of aircraft, the variability of pilot ratings during in-flight investigations of flying qualities, turbulence effects during in-flight simulation, and the use of variable stability aircraft as instructional aids. R.N.A.

N68-17469# Royal Aircraft Establishment, Farnborough (England).
A STUDY OF THE LONGITUDINAL BEHAVIOR OF AN AIRCRAFT AT NEAR-STALL AND POST-STALL CONDITIONS
H. H. B. M. Thomas *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 729-769 refs (See N68-17460 08-02)

The geometric and aerodynamic features of an aircraft design, which result in the variation of the pitching moment coefficient with incidence usually associated with deep stall trouble, are identified and discussed. The aerodynamic background to the problem is presented with emphasis on the pitching moment due to angle of attack and due to elevator deflection. Other factors having a bearing on the problem are also considered, including the lift and drag variation with angle of attack, the damping-in-pitch derivatives, and the possible impact of the time dependence of the aerodynamics on the whole problem. The interrelation between the aerodynamics and the behavior of the aircraft in stalling tests is examined. Two problems arising in such maneuvers are discussed: the degree of deep stall penetration and the ability to arrest such penetration, and the question of whether or not recovery can be effected once the aircraft has stabilized into the super-stall trim condition. Also discussed are problems of pilot cues and instrumentation, and suggestions for flight testing and operating aircraft with deep stall tendencies. R.N.A.

N68-17470# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
STABILITY AND CONTROL ANALYSIS OF AN AIRPLANE BEYOND ITS MAXIMAL LIFT [ANALYSE DE LA STABILITE ET DU CONTROLE D'UN AVION AU DELA DE SA PORTANCE MAXIMALE]

Ph. Poisson-Quinton and E. Erlich *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 771-792 refs In FRENCH (See N68-17460 08-02)

The aerodynamic mechanisms of deep stall are reviewed, and the different flow patterns responsible for this behavior are discussed and depicted. Wind tunnel tests are described in which deep stall was studied in configurations of transport aircraft and aircraft with variable sweep wings. The results show: (1) For the transport aircraft, deep stall occurred for a raised position of the tail assembly, and with the presence of lateral jet engines, provided to sweep away that phenomenon on an anterior configuration. Certain fuselage forms were found to have an adverse effect when the horizontal tail assembly is situated over them. (2) For the variable lift aircraft, the position of the tail assembly above the wing form can lead to a deep stall preceded by a violent self-elevation or nose lift, which deflects the mobile part of the wing. This phenomenon is more severe in the case of a wing deployed with hyperlifting shields; it is shown, on the other hand, that a horizontal tail assembly placed above the wing plane can avoid these longitudinal difficulties. Transl. by M.G.J.

N68-17471# Hamburger Flugzeugbau G.m.b.H. (West Germany).
THEORETICAL CONSIDERATIONS, WIND-TUNNEL RESEARCH AND FLIGHT-TEST RESULTS ON THE SUPER-STALL CHARACTERISTICS OF THE HFB 320 HANSA
Hans Wocke *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 793-808 (See N68-17460 08-02)

The configuration and wing design considerations of the HANSA aircraft are briefly described. The results of early wind tunnel and stall tests are discussed along with later wind tests covering extreme angles of attack which were prompted by accidents to the aircraft. Stall characteristics of the aircraft operating at large angles of attack and recovery procedures are described. A brief description is given of an accident which occurred during an extreme stall test. Various methods of improving the stall characteristics of the aircraft are presented. An anti-stall system for the production version of the aircraft, which consists of a stick shaker as an artificial stall warning device and a stick pusher to prevent the aircraft getting into dangerous angles of attack, is described. Simulator tests demonstrated the proper function of the system. R.N.A.

N68-17473# Hawker Siddeley Aviation, Ltd., Hatfield (England).
THE EFFECT OF LOW ALTITUDE GUSTS ON AUTOMATIC LANDING
J. C. Hall *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 831-853 refs (See N68-17460 08-02)

Progress on the development of an automatic landing system is described with particular emphasis on the problem of gust effects on pitch performance. Although the work is still incomplete, the problem has been solved by introducing more sophisticated control laws into the autopilot. Because of the lack of general data on low altitude gusts, an attempt was made to make as many gust measurements as possible during the automatic landing development program. The instrumentation system initially fitted to the aircraft was not designed with gust investigation in mind, and the accuracy is limited. More refined instruments are now available which provide reliable data on gusts in all three directions. R.N.A.

N68-17474# National Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).
A FEW NOTES ON THE PROBLEM OF SPEED STABILITY
J. Buhrman, F. E. Douwes Dekker, and C. M. Kalkman *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 855-870 refs (See N68-17460 08-02)

An attempt is made to distinguish between speed stability as a form of stability under constraint and speed stability in its general sense, which also covers all other factors contributing to the pilot's opinion on his ability to maintain constant flight path angle and airspeed during the approach. This ability not only depends on lift and drag characteristics of the aircraft but also on a complex of properties of of both aircraft and engine(s). The choice of a suitable approach speed is based on speed stability in its general sense, and to obtain a better insight into this problem, flight tests were conducted with a series of seven aircraft ranging from a conventional twin-engined propeller aircraft to the jet propelled tailless Avro Vulcan. Based on the results, a tentative proposal is given for a flight test procedure for determining a safe approach speed from the viewpoint of speed stability in the general sense, but excluding factors such as the pilot's view from the cockpit, margin to the stalling speed, etc. R.N.A.

N68-17475# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany).
MIXED PILOT AND AUTOMATIC LONGITUDINAL CONTROL DURING LANDING APPROACH
R. Brockhaus *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 871-902 refs (See N68-17460 08-02)

Some characteristics of the aircraft and the human controller were investigated to show that difficulties arise in a mixed pilot and automatic longitudinal control system. The control of speed and height is coupled, i.e., the longitudinal control is a multivariable problem. The performance of the two independently controllable outputs is a function of both inputs, and hence a function of all existing feedback loops. It is therefore impossible to optimize one feedback loop independently of the others. The transfer functions of the aircraft longitudinal mode have a non-minimum-phase character, which restricts controllability. The pilot's control laws are not constant, he uses different variables for short and long terms control, and may change his control laws to suit a changed situation. Moreover the pilot changes his transfer functions, especially his gain factor, over a wide range. It is therefore difficult to set up a standard for pilot control laws, but this is needed to optimize the automatic feedback loops in a mixed system. It would be better to distribute the control task of pilot and automatics to two different modes with low interaction. The pilot should control either the complete longitudinal or the complete lateral motion. R.N.A.

N68-17477*# National Aeronautics and Space Administration, Washington, D. C.
NASA RESEARCH EXPERIENCE ON JET AIRCRAFT CONTROL PROBLEMS IN SEVERE TURBULENCE
Richard J. Wasicko *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 937-955 refs (See N68-17460 08-02) CSCL 01C

A brief summary is presented of a NASA research effort on the jet transport upset and recovery problem and some of the more significant results are discussed. The research program revealed no singular cause for the jet transport upsets, but quantitative data were obtained on several factors which appear to contribute to jet upsets, and piloting techniques which could cause path control difficulties were determined. Those aspects which seem to be more directly related to the flight experienced problem and which are discussed in detail are swept-wing jet transport handling qualities, the flexible vehicle cockpit acceleration environment, piloting techniques, and upset-recovery maneuvers. R.N.A.

N68-17478# Royal Aircraft Establishment, Farnborough (England).
COCKPIT DISPLAYS
D. J. Walters *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 957-977 (See N68-17460 08-02)

A brief history of the development of cockpit instrument displays is given. Despite the deplorable confusion of current instrument panels, new techniques are appearing, based mainly on electronic picture generation, which have a freedom and flexibility inherently absent from electromechanical types. The possibilities and limitations of mechanical displays, head-up displays, and electronic instrument displays are outlined and suggestions are made for

ways in which the characteristics of these different techniques can be used together to obtain an optimum cockpit layout. An optimum three-tiered system is recommended which incorporates: (1) an electronic head-up display presenting director information and the minimum of situation information, (2) an electronic head-down display giving a comprehensive situation display time-sharing, and (3) a set of non-electronic instruments displaying continuously all basic information with the minimum of links between the sensor and the display. R.N.A.

N68-17479# North American Aviation, Inc., Los Angeles, Calif.
OPERATIONAL EXPERIENCE AT MACH 3
A. S. White and P. H. Anderson *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 979-993 (See N68-17460 08-02)

The aerodynamic features and flight characteristics of the XB-70 aircraft are discussed followed by a detailed description of the operation and performance of the aircraft during a Mach 3 flight test. R.N.A.

N68-17481*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
OPEN-ACCESS CW DOPPLER TECHNIQUE FOR COLLISION-HAZARD WARNING
James H. Schrader [1967] 7 p Presented at the FAA Symp. on Pilot Warning Indicators for Aircraft Collision Avoidance, 12 Dec. 1967
(NASA-TM-X-60874) CFSTI: HC $3.00/MF $0.65 CSCL 01D

Consideration is given to a relatively simple, cooperative, continuous wave Doppler technique which employs random coding to permit a number of aircraft to simultaneously interrogate a simple transponder. The protected aircraft transmits a pair of frequency modulated signals which are received at the intruding aircraft and multiplied to derive a signal at the instantaneous difference frequency. This signal is then retransmitted to the protected aircraft and compared to the instantaneous difference in the transmittted pair to derive the Doppler shift. Two basic parameters can be used in deriving a warning: variation in signal level, 60 dB for a decade change in range; and variation in frequency proportional to closing velocity. Various combinations of these parameters can provide a warning threshold based on time-to-closest-approach and/or range. The advantages of the concept are cited as its adaptability to various degrees of protection, no requirements for individual channel assignments and precision control of frequency, and relatively low cost. Limitations are also discussed. M.G.J.

N68-17492# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Flugfuehrung.
ON THE INTERACTION AND THE EFFECT OF NON-MINIMUM PHASE PROPERTIES IN SPECIAL MULTIVARIABLE SYSTEMS BY THE EXAMPLE OF THE CONTROL OF THE LONGITUDINAL MOTION OF AIRCRAFT IN THE APPROACH [UEBER DIE VERKOPPLUNG UND DEN EINFLUSS VON ALLPASSEIGENSCHAFTEN IN SPEZIELLEN MEHRGROESSENREGELSYSTEMEN AM BEISPIEL DER REGELUNG DER FLUGZEUGLAENGSBEWEGUNG IM LANDEANFLUG]
Rudolf Brockhaus (Ph.D. Thesis—Tech. Hochschule Carolo Wilhelimina) Jul. 1967 188 p In GERMAN; ENGLISH summary
(DLR-FB-67-74)

In multivariable control systems, as for example in the control of the longitudinal motion of aircraft, feedback loops not only modify the denominator but also the numerators of the system's transfer functions. The interactions between different feedback loops that result from this fact, and the limitation of possible system improvement through feedback are investigated for the example of flight path control by elevator and throttle. The capability of this method for a stepwise optimization of multiloop systems is demonstrated by an example. It is further shown that non minimum phase effects as a consequence of the thrust moment, a vertical thrust component or flight below minimum drag speed can be completely cancelled in the multiloop system, without affecting the system stability. From a systematic investigation of the interactions in flight path control systems it follows that the capabilities of certain feedback structures are partly due to such elimination of non minimum phase effects. In a discussion of the non minimum phase effect known as "speed instability" the limitations of the "theory of stability under constraint" are shown. Author

N68-17763# Boeing Co., Morton, Pa. Vertol Div.
FEASIBILITY STUDY OF CRUISE FAN PROPULSION SYSTEMS AND ASSOCIATED POWER TRANSFER SYSTEMS FOR COMPOUND/COMPOSITE AIRCRAFT Final Report
F. H. Dean, P. C. Prager, and J. J. Schneider Sep. 1967 468 p refs
(Contract DA-44-177-AMC-336(T))
(D8-0440; USAAVLABS-TR-67-28; AD-663831)

The report examines the feasibility and relative merit of five gas- and shaft-coupled cruise fan propulsion systems in various compound and composite aircraft configurations. A 1970 time period is assumed. Propulsion and airframe parameters are defined, and the results of an optimization process for maximum aircraft relative productivity in a fixed short-range transport mission are shown. Ranges of vehicle disc loading of from 5 to 11 pounds per square foot and of fan bypass ratio of from 3 to 12 are covered. The problems of rotor-fan power transfer systems are reviewed and possible solutions evaluated. Detailed weight data is given for optimum aircraft and propulsion system combinations. Convertible shaft-driven cruise fans in an integrated propulsion system are found to be particularly attractive; however, considerable work is required in development of power management systems. Author (TAB)

N68-17768# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
AN EXPERIMENTAL INVESTIGATION OF THE LONGITUDINAL DYNAMIC STABILITY CHARACTERISTICS OF A FOUR-PROPELLER TILT-WING VTOL MODEL
H. C. Curtiss, Jr., W. F. Putman, and J. V. Labacqz Sep. 1967 124 p refs
(Contract DA-44-177-AMC-8(T))
(Rept.-774; USAAVLABS-TR-66-80; AD-663848)

The results of experiments conducted to evaluate the longitudinal stability characteristics of a 1/10 scale dynamic model of a four-propeller tilt-wing VTOL transport are presented and discussed. The Princeton Dynamic Model Track was used to measure the static stability and the transient response of the model at wing incidences from 90 degrees to 40 degrees. The results are interpreted in terms of full-scale aircraft characteristics. All data are presented for a C.G. position of 90% MAC (the most forward C.G. position of the aircraft is 15% MAC) and the horizontal tail and flap program differ from those presently used on the aircraft. The transient motions at wing incidences above 70 degrees were similar and dominated by high speed stability and low angular damping resulting in an unstable oscillation of approximately a 9-second period for the full-scale aircraft. The responses at wing incidences below 70 degrees were more complex due to a rapid decrease in the speed stability from a large positive value above 70 degrees to a negative value at 60 degrees. The values of the speed stability for the aircraft determined by a detailed analysis of the data in the neighborhood of 60 degrees wing incidence differ from those obtained from a preliminary analysis of the data by the LTV Aerospace Corporation. Typically, at wing incidences between 60 degrees and 40 degrees the linearized static stability derivatives M sub u and M sub alpha were small, nonlinearities were evident, and the small amplitude linearized motion was dominated by a divergence. At 40 degrees wing incidence, indications were that the dynamic motions were becoming stable. Author (TAB)

N68-18015*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AERONAUTICS IN REVIEW: AVIATION IN HISTORICAL PERSPECTIVE
James F. Connors Washington Jan. 1968 61 p refs Presented at Meeting of Lewis Aerospace Explorers, Cleveland, 30 Sep. 1967 Revised
(NASA-TM-X-52354) CFSTI: HC$3.00/MF$0.65 CSCL 01B

A historical review of aircraft is presented, in which the technical highlights in the evolution of the airplane are touched upon and some major events in aviation history are presented. The history of the airplane is divided into six time periods: (1) era of the Wright brothers, (2) World War 1, (3) late 20s and the 30s, (4) World War 2, (5) post-World War 2 (modern jet aircraft), and (6) the future and what lies ahead. The major aircraft of each period is discussed, and photographs are given to show the advancement of aircraft from the Wright brothers era to modern aircraft of today and future aircraft of tomorrow. A brief aviation chronology is also included. B.S.D.

N68-18021*# Techtran Corp., Glen Burnie, Md.
HORIZONS IN THE DEVELOPMENT OF AIRCRAFT AND CONCLUSIONS [PERSPEKTIVY RAZVITIYA LETATEL'NYKH APPARATOV ZAKLYUCHENIYE]
S. I. Zonshayn Washington NASA Feb. 1968 9 p refs Transl. into ENGLISH from Aerodinam. i Konstrukt. Letatel'nykh Apparatov (Moscow), 1966 p 352–360
(Contract NASw-1695)
(NASA-TT-F-11463) CFSTI: HC$3.00/MF$0.65 CSCL 01C

The development of aircraft is seen to be a function of the development of engines and other components, particularly engines. In the future, piloted aircraft will be developed on the same bases as in the past, but with increased demands as to speed, range, etc. The effects of these demands are analyzed. Author

N68-18050# North American Rockwell Corp., Los Angeles, Calif. Aerospace and Systems Group.
NEW CONCEPTS FOR EMERGENCY EVACUATION OF TRANSPORT AIRCRAFT FOLLOWING SURVIVABLE ACCIDENTS Final Report
J. A. Roebuck, Jr. Jan. 1968 419 p refs
(Contract FA-67-WA-1766)
(DS-68-2)

A systems analysis and creative engineering study has resulted in descriptions and theoretical evaluations of 51 new concepts concerning hardware and procedures for improving emergency evacuation of passengers from transport category aircraft following survivable accidents. The 15 major concepts are as follows: (1) application of automatic voice instructions and audio signal devices, (2) active, better distributed lighting mix for interiors and exteriors, (3) use of tactual sense displays, (4) situation displays for the crew, (5) improved interpersonal communication devices, (6) wide-spectrum passenger and crew education program and displays, (7) personal protective devices, (8) improved, general, onboard fire suppressant and prevention systems, (9) automatically and manually controlled cabin venting systems, (10) improved ground support complex, (11) better slide entry and egress devices, (12) better passenger containment and more versatile egress devices, (13) power assistance for doors and egress device deployment, (14) automatic passenger egress devices, and (15) application of cargo handling concepts. Author

N68-18081# National Aerospace Lab., Tokyo (Japan).
OPTIMAL VERTICAL DESCENT PROCEDURE WITH PARTIAL POWER OF MULTIENGINE HELICOPTERS: THE CASE OF REJECTED TAKE-OFF
Masaki Komoda 1967 23 p refs
(NAL-TR-139) CFSTI: HC$3.00/MF$0.65

Optimal vertical descent procedure with partial power following a sudden failure of a "critical engine" is analyzed for multi-engined helicopters. The optimal procedure which maximizes C.D.P. (critical decision point) height is obtained as a solution of a variational problem of single degree of freedom, and with partially-free and partially-fixed end conditions. With some simplifying assumptions including linearization of power coefficient with respect to thrust coefficient, Euler's equations degenerate to give a holonomic relationship between the rotor rpm and the rate of descent. Setting up a "standard procedure" which is close to the "optimal procedure" and which, at the same time, simulates possible pilot operation in practice, a simple method to predict C.D.P. height is derived. Sample calculations are shown. Author

N68-18192*# Techtran Corp., Glen Burnie, Md.
FUNDAMENTAL PRINCIPLES FOR DESIGNING AIRCRAFT [OSNOVNYYE PRINTSIPY PROYEKTIROVANIYA LETATEL' NYKH APPARATOV]
S. I. Zonshayn Washington NASA Feb. 1968 29 p Transl. into ENGLISH from Aerodinam. i Konstrukt. Letatel'nykh Apparatov (Moscow), 1966 p 322–351
(Contract NASw-1695)
(NASA-TT-F-11415) CFSTI: HC$3.00/MF$0.65 CSCL 01C

A fundamental review is presented of the process of creation of an aircraft: a wide range of aircraft design problems is covered, including: stages in development of a plan, factors influencing aircraft weight and balance, calculation of landing speeds and associated wing stresses, high altitude performance and ceilings, takeoff run lengths, maximum flight speed as influenced by power, materials selection, usage of standard parts, problems of helicopter and missile design, including multi-stage missiles, and the relationship between engine types and aircraft capabilities. Author

N68-18222# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.
PILOT WARNING INSTRUMENTS
1967 199 p refs Symp. held at Washington, D. C., 12 Dec. 1967

Symposium proceedings dealing with pilot warning indicators for collision avoidance and aircraft safety are presented. For individual titles see N68-18223–N68-18242.

N68-18223# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.
MID-AIR COLLISION STATISTICS
In its Pilot Warning Instr. 1967 p 1–12 (See N68-18222 08-02)

Details are tabulated for mid-air collisions that occurred in the United States between February 1, 1959 through the end of 1966, and preliminary data are submitted for three crashes that took place in 1967. Location of the crash, type of aircraft, fatalities, and kind of flying are noted in each case. M.W.R.

N68-18224# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.
U. S. ARMY REQUIREMENTS FOR AIRCRAFT COLLISION PREVENTION
W. C. Robinson *In its* Pilot Warning Instr. 1967 p 13–14 (See N68-18222 08-02)

Installation of a collision warning and terrain/obstacle avoidance system aboard aircraft is cited as the only current Army requirement for aircraft collision avoidance. Purposes of such systems are to provide warnings relating to possible collisions of aerial vehicles operating under reduced visibility conditions, as well as warnings of obstacles to aircraft flying at low altitudes. M.W.R.

N68-18225# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

REMARKS ON U. S. ARMY MID-AIR COLLISIONS

R. Merritt *In its* Pilot Warning Instr. 1967 p 15–18 (See N68-18222 08-02)

Mid-air collisions in Army areas of operations are attributed primarily to both the high density and the training mission and basic instrument instruction rather than to high rates of closure that pose hazards for other branches of the armed forces. Specifically, it is noted that Army aircraft of the same type and flying the same mission have caused most of the mid-air accidents recorded by the Army; and that more definite control of the airspace was initiated following many mid-air accidents, incidents, and near-misses. Various mechanical preventive measures are reviewed, and the need for a positive means of warning pilots of imminent danger is stressed. M.W.R.

N68-18226# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

NAVY PRESENTATION

Charles H. Taylor *In its* Pilot Warning Instr. 1967 p 19–24 (See N68-18222 08-02)

Because of the nature of Navy experiences with mid-air collisions, efforts have been directed primarily toward development of stationkeeping equipments for use by associated aircraft. In this regard, it is noted that approximately 2/3 of the collisions involved these associated aircraft; that is, aircraft operating together within relatively small areas of airspace. Of the remaining 1/3 of the collisions involving so-called non-associated aircraft, 25% occurred during landing while under control of tower or other personnel and 75% between aircraft operating at cruise altitudes between a few hundred feet and 40,000 feet. Further, the larger number of daytime collisions versus those occurring at night is directly related to the number of sorties during the day as opposed to those at night. Differences between military and civilian air travel patterns are noted, and specific note is made of the low altitude submarine search patterns and carrier aviation. M.W.R.

N68-18227# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

AIR FORCE PRESENTATION

C. E. Hammett *In its* Pilot Warning Instr. 1967 p 25–27 (See N68-18222 08-02)

Since the vast majority of Air Force mid-air collisions occur when the locations of the colliding aircraft are actually known to each other, aids other than ground-based radar are required for accident avoidance. Equipments are required by the military to take care of multiple threats as well as to vary the warning time available to pilots. The weight of additional instrumentation is considered a significant problem. M.W.R.

N68-18228# Syracuse Univ. Research Corp., N. Y.

THE USE OF REDUCED BANDWIDTH COCKPIT FOR PWI

George M. Kirkpatrick *In* FAA Pilot Warning Instr. 1967 p 29–37 (See N68-18222 08-02)

Use of airborne TV for pilot warning instruments (PWI) systems is considered; and a cockpit TV system that offers 360 degree coverage, bearing, approximate heading and speed on other aircraft, and costs under $200 is discussed. Major limitation of the use of airborne TV for PWI is the lack of spectrum for full bandwidth TV; and the use of slow scan TV techniques is considered to reduce the bandwidth required for the ground to air channel. Use of a time delay is considered an advantage of the system because it reduces the temptation for the imprudent pilot to use the display to initiate avoidance action. In addition, a slowly changing time-elapse display offers less distraction to the pilot and leaves adequate time for the routine visual search. Time delay versus bandwidth is graphed for TV picture transmission, and a flow chart is included for an improved narrowband cockpit TV with a time delay. M.W.R.

N68-18229# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

NBAA LOOKS AT PWI

Fred McIntosh *In its* Pilot Warning Instr. 1967 p 39–54 (See N68-18222 08-02)

The need for airborne collision avoidance systems is stressed, and the requirements for PWI (pilot warning instrument) development are detailed. Developments for aircraft carriers are noted, and the lack of much-needed PWI systems for other types of aircraft is stressed. The PWI is needed to give knowledge of the presence of another aircraft, the relative elevation of the intruder, and the relative bearing of the intruder in a self-contained device. The need for immediate development and production of such a device is emphasized. M.W.R.

N68-18230# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

AOPA POSITION PAPER

Roys Jones *In its* Pilot Warning Instr. 1967 p 55–59 (See N68-18222 08-02)

The installation of a simple pilot warning device aboard an aircraft is considered essential for collision avoidance, and the fact that present technology has the know-how to develop such a device is stressed. Centralized leadership on the part of the FAA is suggested to channelize the needed research and development. M.W.R.

N68-18231# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

ATA PRESENTATION

Frank C. White *In its* Pilot Warning Instr. 1967 p 61–67 (See N68-18222 08-02)

The long-time search by the scheduled airlines for an improved means of air collision prevention is noted; and efforts have been related to the air traffic control (ATC) system, airborne collision avoidance system (CAS) development, and proximity or pilot warning indicators (PWI). The airlines have placed greater emphasis on a CAS, because its need was considered greater than that of a PWI. However, the need for a PWI system is also considered essential at the present time, particularly since FAA reports indicate that alerting the pilot to the mere presence of another aircraft is of some value. Investigation of infrared detectors is noted, and a statement of civil users' requirements for PWI is presented. M.W.R.

N68-18232# Federal Aviation Agency, Washington, D. C. Dept of Transportation.

AIR LINE PILOTS ASSOCIATION'S VIEWS ON PWI

A. E. Smith *In its* Pilot Warning Instr. 1967 p 69–70 (See N68-18222 08-02)

Immediate development of useable pilot warning indicators is considered necessary for airborne collision avoidance, particularly for light aircraft that do not have collision avoidance systems. Investigation of the conspicuity enhancement provided by fluorescent paint is suggested because it is felt that many aircraft collisions could be avoided in this way. M.W.R.

N68-18233# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

PRELIMINARY STATUS REPORT ON FEASIBILITY STUDIES OF A PILOT WARNING INDICATOR

Charles H. Leigh *In its* Pilot Warning Instr. 1967 p 71–84 (See N68-18222 08-02)

Feasibility of using infrared detection devices is discussed for detecting and tracking single and multiple aircraft at limited ranges under visual flight rule (VFR) conditions. A high intensity xenon discharge light in combination with a diffused silicon detector is considered to hold promise for a simple pilot warning indicator; and the xenon source was capable of being detected at ranges in

excess of the required 3 to 5 miles. When haze limited visibility to 3 miles, the source was still detectable. The investigated concept is considered a relatively cheap means of providing a partial solution to the hazard avoidance capability of general aviation aircraft in VFR conditions in terminal areas rather than as a substitute for an automatic collision avoidance system. M.W.R.

N68-18234# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

OPEN-ACCESS C.W. DOPPLER TECHNIQUE FOR COLLISION-HAZARD WARNING

James H. Schrader *In its* Pilot Warning Instr. 1967 p 85–92 (See N68-18222 08-02)

A relatively simple, cooperative, CW doppler technique is described that employs random coding to permit a number of aircraft to simultaneously interrogate a simple transponder. Essentially, the protected aircraft transmits a pair of frequency modulated signals of f_1 and f_2 which are received at the intruding aircraft and multiplied to derive a signal at the instantaneous difference frequency. This signal is received by protected aircraft, where the doppler shift is derived. Warning can be provided either by variation in (1) signal level, 60 dB for a decade change in range, or (2) frequency proportional to closing velocity. It is stressed that this is one of the collision hazard devices under investigation; and advantages and limitations of such a technique are discussed.

N68-18235# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

PWI FREQUENCY CONSIDERATIONS

I. D. Goldman *In its* Pilot Warning Instr. 1967 p 93–101 (See N68-18222 08-02)

The five bands allocated to the aeronautical radionavigation service, the three to the radionavigation service, and four additional bands are considered for use in pilot warning indicators (PWI). Since all of these bands are shared by both government and nongovernment services, frequency assignments within them are subject to coordination by IRAC and FCC. Capabilities and limitations of these 12 bands are noted; and it is noted that the upper limit of government control is presently at 3THz or the lower part of the infrared spectrum. Assignment of operational PWI equipment to one band is considered essential; as is cooperation with Canada, Mexico, and other countries and the consideration of PWI's and collision avoidance systems on an international basis. M.W.R.

N68-18236# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

ALTITUDE RHO/THETA PILOT WARNING INSTRUMENT

J. L. Brennan *In its* Pilot Warning Instr. 1967 p 103–121 (See N68-18222 08-02)

A cooperatively developed rho/theta Pilot Warning Instrument (PWI) is described that can display any similarly equipped intruding aircraft that is within ±1000 ft altitude and 25 miles and is located in the forward hemisphere relative to the nose of the detecting aircraft. The 18-lb equipment has a volume of .75 ft^3; comsumes 80 watts of 28-volt dc power; and consists of one transmitting and three receiving units, a transmitter-receiver unit, a data processor unit, a barometric coder–decoder unit, and a display unit. Although the desired altitude acceptance band has not been specified, the existing band appears to be excessively wide and can be made smaller by redesign. Range accuracy of the device was considered adequate, although the bearing error was considered excessive for the particular application. Device performance was seriously degraded by self-generated, ground-reflected interference signals; and the PWI technique used in the equipment was not considered reliable for pilot use as an aid to airborne collision prevention. M.W.R.

N68-18237# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

INFRARED STUDIES

O. E. McIntire *In its* Pilot Warning Instr. 1967 p 123–138 (See N68-18222 08-02)

Optical techniques in the application of infrared radiation were studied in relation to the detection of intruder aircraft for pilot warning instruments. Beginning with passive infrared detection of aircraft, this program progressed to infrared detection of enhanced aircraft and, finally, to cooperative infrared detection of other aircraft. The last involved a PWI system using a rotating beacon transmitter on one aircraft and a receiver on a second; and an improved version can detect the beacon at a range of 17,000 ft at night, 5,000 ft on a clear day, and as low as 1,000 ft on a cloudy day. Even with an optical filter installed, background discrimination is poor; and, even with improvements, capabilities of this infrared system are considered marginal. M.W.R.

N68-18238# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

SPERRY GYROSCOPE COMPANY EXPERIMENTS

In its Pilot Warning Instr. 1967 p 139 (See N68-18222 08-02)

A brief summary is presented of the contents of a report entitled, "A Study of Requirements for A Pilot Warning Instrument for Visual Airborne Collision Avoidance." It is noted that this report includes a listing of the program and simulation limitations; a discussion of the simulator and the subject's environment; and the experimental designs resulting in the detection, evaluation, and maneuver related to the warning system. M.W.R.

N68-18239# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

CURRENT AND FUTURE PROGRAMS IN PWI

P. Rich *In its* Pilot Warning Instr. 1967 p 141–145 (See N68-18222 08-02)

The need for a Pilot Warning Instrument (PWI) is emphasized by statistics indicating that 75% of mid-air collisions involve private aircraft, 14% air carrier aircraft, and 11% military aircraft. The imminent availability of a collision avoidance system which should protect air carrier aircraft from each other will, hopefully, eliminate 14% of the accidents; but a pilot warning indicator is needed to avoid other collisions. Past FAA efforts are described; and a project concerning the analysis of visual separation techniques and testing of PWI devices is underway that is primarily concerned with specifications for a PWI and illusion problems. M.W.R.

N68-18240# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

AVAILABLE MATERIAL PERTAINING TO PILOT WARNING INSTRUMENTS (PWI)

In its Pilot Warning Instr. 1967 p 147–149 (See N68-18222 08-02)

A bibliography of 26 documents related to pilot warning instruments is presented that deals with visual collision avoidance, infrared detection techniques, pilot judgments, and other aspects of aircraft accident prevention. M.W.R.

N68-18241# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.

COPAG PWI CHARACTERISTICS

In its Pilot Warning Instr. 1967 p 151–160 (See N68-18222 08-02)

An overview of terminology, definitions, and characteristics of pilot warning indicators (PWI) is presented; and both collision avoidance systems and conspicuity enhancement are mentioned. The development of cooperative versus self-contained PWI's is considered; and detection, assessment, and maneuver aspects of collision avoidance are noted. M.W.R.

N68-18242# Federal Aviation Agency, Washington, D. C. Dept. of Transportation.
NEAR MIDAIR COLLISION STUDY
In its Pilot Warning Instr. 1967 p 161-167 (See N68-18222 08-02)
(AC-00-23)

An advisory circular notes the intention of the FAA to make a one-year study of near mid-air collisions; and invites all concerned aviation personnel to report such incidents that occur during 1968. Procedures for reporting incidents are outlined, including the initial radio report and the complete written report. Policy regarding reports of near mid-air collisions is also detailed. M.W.R.

N68-18250*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOW-SUBSONIC FLIGHT AND FORCE INVESTIGATION OF A SUPERSONIC TRANSPORT MODEL WITH A DOUBLE-DELTA WING
Delma C. Freeman, Jr. Washington Mar. 1968 47 p refs
(NASA-TN-D-4179) CFSTI: HC $3.00/MF $0.65 CSCL 01C

An investigation has been conducted in the Langley full-scale tunnel to determine the low-speed static and dynamic longitudinal and lateral stability characteristics of a 1/20-scale model of a double-delta supersonic commercial air transport configuration. The results of the investigation showed that the dynamic longitudinal stability and control characteristics of the model were generally satisfactory over the test angle-of-attack range except from about 20° to 25° where neutral or negative static longitudinal stability made flying difficult. The Dutch roll oscillation was well damped throughout most of the test angle-of-attack range but the damping decreased rapidly above an angle of attack of about 20°. The use of a roll-rate damper to provide artificial stabilization in roll generally gave satisfactory Dutch roll characteristics over the test angle-of-attack range. The directional stability was satisfactory at low angles of attack but deteriorated rapidly at the high angles of attack and the model diverged in yaw against full corrective control near an angle of attack of 28°. The lateral control characteristics were satisfactory over the test angle-of-attack range. Author

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N68-17223*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SPACE VEHICLE MISSILE POWER SUPPLIES Annotated Bibliography
Mildred Benton (George Washington Univ.) Redstone Arsenal, Ala. Redstone Sci. Inform. Center Nov. 1967 226 p refs Prepared jointly with NASA and Army
(Contract DAAHO1-67-C-1036(Z))
(NASA-TM-X-60877; RSIC-743) CFSTI: HC $3.00/MF $0.65 CSCL 10A

This annotated bibliography contains 700 citations from open literature on power supplies. It is oriented toward batteries, fuel cells, thermionics, thermoelectrics, nuclear energy sources, and other new concepts of direct energy conversion which may be adaptable to space vehicles. Author

N68-17232*# Monsanto Research Corp., Everett, Mass. Boston Lab.
SEPARATOR DEVELOPMENT FOR A HEAT STERILIZABLE BATTERY Quarterly Summary Progress Report No. 4, 1 Oct.-31 Dec. 1967
John J. O'Connell, Elizabeth A. McElhill, and Carl A. Olson 31 Dec. 1967 22 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951524)
(NASA-CR-93176; MRB6234Q4) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Two ligand-containing polymers were developed and prepared as 1.5 mil flexible films that have satisfactory electrical and mechanical properties as separators for sterilizable silver-zinc cells. One type is a modified styrene-maleic anhydride-methyl methacrylate-methyl acrylate tetrapolymer with high content of hydrolyzable anhydride and acrylate groups. Methods were developed to crosslink these polymers with bis(4-anilino)methane during film formation to make them usable separator materials by insolubilizing them in 40% KOH. Tests on duplicate samples from different batches of this type polymer showed good reproducibility. The second type polymer, 31:69 2-vinylpyridine-methyl methacrylate copolymer, had shown promising electrical properties in our initial program. The mechanical properties of films of this polymer, both before and after sterilization, were improved in increasing its molecular weight. Author

N68-17233*# Thermo Electron Engineering Corp., Waltham, Mass.
THERMAL ENERGY STORAGE/CONVERTER PROTOTYPE DESIGN, FABRICATION AND TESTING Final Report
B. Gunther, S. Merra, and P. Pantazzelos Jan. 1968 42 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950976)
(NASA-CR-93177; TE-4049-30-68) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A program was conducted to join a container of thermal energy storage (TES) material to a thermionic converter to demonstrate the feasibility of using stored energy to power the converter when solar power was not available. Results showed that a rhenium container of TES material 3 BeO-2 MgO can be integrated with thermionic converter using available fabrication technology. The exposed surface of the container can be adequately shielded with multilayer radiation shields to concentrate the bulk of heat into the thermionic emitter. During testing of a TES container in which the oxide was slowly heated and melted, an oxide leak developed. Another container was constructed in an attempt to achieve a leak-tight unit, but it also leaked after the oxide was melted. This container also showed severe distortion as if a large pressure had been exerted against the inner walls causing them to bulge outwards. The source of the pressure could not be determined. The method used to calculate the output of the container during cool-down was proved valid. R.N.A.

N68-17299*# Globe-Union, Inc., Milwaukee, Wis. Applied Research Lab.
A PROGRAM TO DEVELOP A HIGH-ENERGY DENSITY PRIMARY BATTERY WITH A MINIMUM OF 200 WATT HOURS PER POUND OF TOTAL BATTERY WEIGHT Final Report, Jul. 1964-Sep. 1967
William E. Elliott and Robert F. Amlie Sep. 1967 280 p refs
(Contract NAS3-6015)
(NASA-CR-72364) CFSTI: HC $3.00/MF $0.65 CSCL 10C

This extensive study included a large number of non-aqueous electrolytes, electrodes and cell systems which were theoretically promising for high-energy density batteries. Conductivity and stability were emphasized in the electrolyte investigation, and the solvent N-nitrosodimethylamine (NDA) was found to be particularly promising in both respects. Lithium and calcium were found to be the most satisfactory anode metals. Discharge capacities and rates of experimental cells were limited by the cathodes. Impurities

usually exhibit a critical effect on performance, and the necessity to detect and remove them in order to characterize an electrochemical system was demonstrated. Author

N68-17342*# Electronic Storage Battery Co., Yardley, Pa. Carl F. Norberg Research Center.

HEAT STERILIZABLE, IMPACT RESISTANT CELL DEVELOPMENT Interim Summary Report, 24 Sep. 1965–30 Sep. 1967

G. W. Bodamer, ed. 30 Sep. 1967 196 p refs Prepared for JPL

(Contracts NAS7-100; JPL-951296)

(NASA-CR-93180) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Standard silver electrodes resist heat sterilization and give rated electrical capacity, but require strong internal metal supports to survive high impact shock. Zinc electrodes must not contain mercury oxide, since the solubility of the latter in KOH at sterilization temperatures permits it to migrate to the silver electrode, amalgamate with it, and decrease its capacity. Zinc electrodes also need reinforcement with strong metal supports. The separators are not adversely affected by heat sterilization when wet with concentrated KOH. The electrolyte should be 35 to 45% KOH saturated with zincate ion. Filled polyphenylene oxides are good case materials from the standpoint of resistance to sterilization, decontamination, and severe shock, and for their ability to be sealed with epoxy adhesives. Sealed, sterilized cells often show unexpectedly high pressures during formation, and nearly always show considerably diminished capacities. Cell designs have been evolving toward greater shock resistance. The use of stronger internal metal supports in the electrodes is expected to improve this property. Author

N68-17493*# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.

SEPARATOR DEVELOPMENT FOR A HEAT STERILIZABLE BATTERY Quarterly Report, Oct. 1–Dec. 31, 1967

L. C. Scala and G. D. Dixon 31 Dec. 1967 21 p Prepared for JPL

(Contracts NAS7-100; JPL-951525)

(NASA-CR-93194; QR-6) CFSTI: HC $3.00/MF $0.65 CSCL 10C

The investigation of the effect of varied zirconium oxide loadings in the coating of Webril tape for battery separators showed that: (1) higher oxide loadings result in faster electrolytic diffusion; (2) lower resistivities are also a result of high oxide loadings; (3) the coatings tend to be more prone to cracking. Best results are obtained at a 3:1 oxide:polysulfone ratio, at a speed of 3–4 ft/min. Ball milling the coating mixtures for several days results in smoother coatings and better filling of the Webril tape voids. Long term exposure to concentrated KOH of battery separator material containing polysulfone 361 instead of polysulfone 1700 as binder indicated that PS 361 dissolves almost completely in the caustic. Separator material containing PS 1700 withstands the sterilization cycle satisfactorily. The continuous coating apparatus is being modified to allow dip coating of the basic tape instead of doctor knife coating. The polarograph has been calibrated to test for silver ion diffusion. Author

N68-17498*# Bendix Corp., Southfield, Mich. Research Labs. Div.

DESIGN AND DEVELOPMENT OF A PNEUMATIC GIMBAL ACTUATION SYSTEM Final Report

Jun. 1967 80 p

(Contract NAS8-5407)

(NASA-CR-61565; Rept.-3775) CFSTI: HC $3.00/MF $0.65 CSCL 13G

The results are presented of a development program to upgrade the performance of the Bendix J-2 pneumatic gimbal actuator. The pneumatic gimbal actuator was upgraded by replacing the vane type servomotor with a higher performance gear type servomotor. The gear servomotor's performance was demonstrated on the existing gimbal actuator with hydrogen gas at −250°F and 800 psig supply pressure. The performance improvement over the vane servomotor was achieved as predicted. The frequency response of the actuator driving a simulated load was improved to over 10 cps from the original vane motor's 3 cps. The new servomotor's performance was further demonstrated by running all of the performance tests required by the above specification, and the results are included in this report. The conclusions of this program confirm that a pneumatic gimbal actuator unlimited by operating temperature can perform to the J-2 engine requirements. Author

N68-17546*# Radio Corp. of America, Camden, N. J. Astro-Electronics Div.

NIMBUS-D SOLAR-CONVERSION POWER SUPPLY SUBSYSTEM Quarterly Technical Report, 15 Sep.–15 Dec. 1967

15 Jan. 1968 40 p

(Contract NAS5-10470)

(NASA-CR-93292; AED-R-3272; QTR-1) CFSTI: HC $3.00/MF $0.65 CSCL 10B

The activities and plans that relate to the technical and schedule pursuance in developing the power supply subsystems are presented. The system, which consists of eight identical storage modules, one control module, and two solar-cell platforms, is to provide the satellite with electrical power. The test methods, conditions, and data summary for the solar cell modules are covered. The storage cells are discussed in relation to procurement and alternation of the negative terminals of each cell. Fabrication tools for storage module machining are listed, and reliability engineering for the system's semiconductors, resistors, and capacitors is cited. The mechanical inspection, cleaning, and electrical procedures for the solar modules are outlined. Histograms for current output and circuit voltage of 10-cell modules are shown, along with the histograms of the six-cell modules. B.S.D.

N68-17565# Varo, Inc., Santa Barbara, Calif. Electrokinetics Div.

DEVELOPMENT OF GENERATOR DIRECT CURRENT G-63( )/G (HAND CRANKED) Final Report, Jul. 8, 1965–Nov. 15, 1966

K. J. Widiner Mar. 1967 60 p

(Contract DA-28-043-AMC-01605(E))

(Rept.-2; ECOM-TR-01605-F; AD-651070)

The Generator, Direct Current, G-63 ( )/G developed encompasses the requirements of USAEC-OM Technical Requirement SCL 7828. Major component or subassembly areas involved with unit development may be classified as: Alternator and associated circuitry, mechanical drive, housing, and base assembly. Electrical subsystem development included alternator optimization, rectifier selection, and design of protection and electrical output monitoring circuitry. Mechanical drive development involved matching the harmonic drive to alternator requirements and additional testing required to isolate and rectify problems of low drive efficiency and high acoustic noise levels generated. The housing was developed for minimum size and weight for containment of the alternator-drive subassembly and maximum acoustic noise suppression. The mounting base assembly developed includes consideration for universal functioning and prime factors of weight, strength, and attachment. Techniques were considered and implemented throughout the project to promote economical use of parts and fabrication processes. Use of standard parts and components where possible and joining major subassemblies such as housing and base components with the dip brazing process have been incorporated toward an economy which may become even more significant in mass production considerations. Overall unit considerations resulted in an effort to integrate individual subsystem attributes into an

economical unit incorporating factors contributing to operator efficiency for total operation and observation as encountered under field conditions. Author (TAB)

N68-17567*# Atlas Chemical Industries, Inc., Valley Forge, Pa. Aerospace Components Div.

DESIGN AND FABRICATION OF FOUR PIN HIGH PRESSURE SQUIB Quarterly Report

J. A. Barrett 16 Dec. 1967 47 p Prepared for JPL

(Contracts NAS7-100; JPL-951912)

(NASA-CR-93182; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 10C

This report covers work performed in developing, providing design and production drawings for, and manufacturing an initial developmental production quantity of squibs to withstand the extremes of thermal shock and other rigid environmental requirements of deep space probe vehicles. The squib must be capable of withstanding heat sterilization of 293°F for 324 hours. It must be capable of functioning at any temperature from −200°F to +300°F, and must be suitable for exposures of up to one year at any temperature from −400°F to +250°F. In addition, the squib must withstand pressures of up to 30,000 psi without seal failure and must be capable of functioning normally after repeated discharges of 25 kV from a 500 picofarad capacitor. The squib will be a 1 amp, 1 watt no fire, dual circuit squib, whose output and initiation characteristics will be as uniform as is possible within the current limitations of the state-of-the-art. Author

N68-17650# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).

INTRODUCTION TO THE STUDY OF RADIATION EFFECTS ON THIN FILM SOLAR CELLS [INTRODUCTION A L'ETUDE DE L'IRRADIATION DES CELLULES SOLAIRES EN COUCHES MINCES]

J. Bernard Nov. 1967 15 p refs In FRENCH

(CERTS-NT-02-2) CFSTI: HC $3.00/MF $0.65

A brief description of CdTe and CdS thin film solar cells is given. Radiation effects in space environment are studied. A program of tests at ambient temperature of the effects of 50 KeV–1 MeV protons and of 100 KeV–3 MeV electrons is reported. ESRO

N68-17741*# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.

CHARACTERIZATION OF RECOMBINATION AND CONTROL ELECTRODES FOR SPACECRAFT NICKEL-CADMIUM CELLS Final Report, Jun. 9, 1966–Jun. 9, 1967

S. Lerner 9 Jun. 1967 60 p

(Contract NAS5-10241)

(NASA-CR-93244) CFSTI: HC $3.00/MF $0.65 CSCL 10C

During this period the adhydrode and fuel cell materials were evaluated for use as scavenger electrodes. The AB6X material was found best for recombination purposes. Efforts on the signal electrode were limited to improving the effectiveness of the adhydrode as a signal electrode by determining the optimum location for it in the cell. The best signal-to-pressure response by the adhydrode was in the center of the pack. The results of cell tests showed that the recombination rate of oxygen in cells with scavenger electrodes is greater than that in cells without them. The cell pressure and the adhydrode signal decay sufficiently during a short discharge to allow for immediate recharge, and vigorous oxygen generation is delayed when charging. Cells containing the AB6X fuel cell material have a hydrogen scavenging ability. Cycling at 60% depth of discharge in a near earth orbit was found to be a feasible mode of operation with signal electrode charge control; however, degradation in cycle life occurs at this depth of discharge. Author

N68-17793 Advisory Group for Aerospace Research and Development, Paris (France).

COMBUSTION AND PROPULSION

H. M. de Groff, ed., J. Fabri, ed., R. F. Hoglund, ed., T. F. Nagey, and M. E. Rumbaugh, Jr. London (New York), Gordon and Breach Sci. Publishers 1967 900 p refs In ENGLISH and FRENCH Presented at 6th Colloq. on Energy Sources and Energy Conversion, Cannes, France, 16–20 Mar. 1964

(AGARDograph-81)

In the panel papers presented, emphasis is focused on dynamic energy conversion, and the thermal, chemical, and radiant sources of direct energy conversion. For individual titles, see N68-17794 through N68-17830.

N68-17795 Pennsylvania Univ., Philadelphia.

SOLAR COLLECTION LIMITATIONS FOR DYNAMIC CONVERTERS

George L. Schrenk *In* AGARD Combust. and Propulsion 1967 p 25–46 refs (See N68-17793 08-03)

A mathematical model for analysis of actual solar collectors has been developed. This model allows one to calculate the energy flux on any arbitrarily shaped focal surface from any arbitrarily shaped collector surface without making numerical approximations. Provisions are included for treating random surface errors on the reflector surface, orientation errors of any size, and vignetting of reflected light by a cavity opening. Typical results from this model are presented to show the effects of surface and orientation errors. This model has recently been used to investigate the interface between the collector and the heat receiver—the cavity opening. The directional assumption ordinarily made for this interface is that this opening can be treated as if it were a plane surface that emitted radiation according to Lambert's law (i.e., the cosine law). Results are presented that clearly show that this assumption is in substantial error for both perfect and imperfect collectors. Detailed analytical work has been performed on cylindrical heat receivers coupled with typical collectors. An "open cavity" Fredholm integral equation approach and the valid directional distribution have been utilized. The effects of the absorptivity and emissivity of the walls of the heat receiver have been investigated; reradiation losses and system performance have been calculated. The results presented differ significantly from the usual engineering estimates used in the design of solar power systems. Author

N68-17796 Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. Electromechanical Div.

RADIATOR DESIGN LIMITATIONS FOR DYNAMIC CONVERTERS

Alfred Koestel and Carmeron M. Smith *In* AGARD Combust. and Propulsion 1967 p 49–109 refs (See N68-17793 08-03)

This paper reviews the technology for design of radiators associated with dynamic converters in which the working fluid is condensed directly in the tubes of the radiator. In the first part of the paper the general design procedure and its optimization are discussed. Various constraints, namely, (1) condensing fluid mechanics; (2) radiation heat transfer from fins and tubes; and, (3) meteorite protection; are integrated through use of information flow charts indicating the sequence of computations. The appropriate equations and their source are noted. A method for estimating the optimum condensing temperature is explained and developed. The application of Lagrangian multipliers in the optimization of design is discussed. The second part of the paper describes the fluid mechanics of the condensing process. Single-phase boundary layer stability techniques are applied to two-phase flow mechanics for purposes of predicting the transition of flow regimes. Experimental data which correlate wetting and nonwetting characteristics in the forced convection condensation of mercury are presented. Critical mercury drop size measurements at incipient entrainment are described and the conditions for "fog flow" of entrained liquid are defined. In conclusion, a review of problem areas of interest to designers of condensers for space power systems is presented. This

review includes gravity effects such as: (1) runback (slugging) instability in vertical tubes; (2) horizontal tube gravity effects, and (3) the Rayleigh–Taylor instability. Author

N68-17798 Pennsylvania Univ., Philadelphia.
PROSPECTS FOR THERMAL ENERGY STORAGE
Manfred Altman *In* AGARD Combust. and Propulsion 1967 p 135–149 refs (See N68-17793 08-03)
(Grant NsG-316)

This paper is concerned with the problem of developing a method of storing thermal energy by the utilization of the heat of fusion of suitable compounds. The first part of the paper discusses the incentives for the development of this type of energy storage. The second part deals with the problem of synthesising suitable materials. The third part discusses the problem of obtaining the needed heat transfer properties. The main conclusions of this work are as follows: (1) A good case can be made for space power systems utilizing thermal energy storage. (2) This is predicated on technical developments which appear probable, but which have not yet been accomplished. (3) A great deal of work remains to be done in two major research areas. One, the determination of phase diagrams of promising eutectic mixtures, and two, the experimental and theoretical determination of heat transfer properties. (4) A carefully planned systematic approach is needed to obtain the information necessary for systems comparisons. Author

N68-17799 Societe Hispano-Suiza, Bois-Colombes (France).
THERMODYNAMIC ASPECTS IN TWO PHASES FOR SPACE APPLICATIONS [THERMODYNAMIQUE DU CYCLE A DEAUX PHASES POUR APPLICATIONS SPATIALES]
J. Plotkowiak *In* AGARD Combust. and Propulsion 1967 p 153–179 refs In FRENCH; ENGLISH summary (See N68-17793 08-03)

Study of the possible use of the Rankine cycle in gas turbines for space applications and definition of the lower power limit which would still provide good performances. Research of working fluids suitable for these engines. Analysis of losses and effect of irreversible processes within the various components of the power plant on the system efficiency. Technological limitation and possible development of a low-power turbocompressor unit using the Rankine cycle. Author

N68-17800 Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Paris (France).
THERMODYNAMIC ASPECTS OF THE BRAYTON CYCLE FOR SPACE APPLICATIONS [THERMODYNAMIQUE DU CYCLE DE BRAYTON POUR APPLICATIONS SPATIALES]
P. Barthelemy, C. Chauvineau, and G. Dieulot *In* AGARD Combust. and Propulsion p 181–205 refs In FRENCH; ENGLISH summary (See N68-17793 08-03)

Thermodynamic aspects of the Brayton cycle for space applications. Need for using a high mass heat, high thermal conductibility heating fluid. Investigation of a carbon suspension within a neutral gas. Research on the advantages of a turbocompressor unit operating on a Brayton cycle and using such a fluid. Author

N68-17801 Societe d'Etude de la Propulsion par Reaction, Villejuif (France).
THERMODYNAMIC ASPECTS OF PISTON MOTORS FOR SPACE APPLICATIONS [THERMODYNAMIQUE DES MOTEURS A PISTONS POUR APPLICATIONS SPATIALES]
M. Vernet-Lozet *In* AGARD Combust. and Propulsion 1967 p 207–221 refs In FRENCH; ENGLISH summary (See N68-17793 08-03)

Review of the Stirling cycle characteristics and possible use of alternative engines for power supply on space vehicles. Comparison of the performances of various types of engines. Studies of the specific mass of a power plant using a solar collector as power source. Research on radiator temperature minimizing this specific mass. Author

N68-17802 AiResearch Mfg. Co., Los Angeles, Calif.
WORKING GAS SELECTION FOR THE CLOSED BRAYTON CYCLE
John L. Mason *In* AGARD Combust. and Propulsion 1967 p 223–252 refs (See N68-17793 08-03)

Systems based on the Rankine cycle have received primary attention in the last decade for nuclear-turboelectric space power production in the kilowatt range. However, recent developments in high-temperature energy sources, continued progress in component efficiency and reliability coupled with liquid metal handling problems in Rankine cycle systems have caused a refocusing of attention on the Brayton cycle. The properties of the cycle working gas influence the design of all major components except the alternator. Gas selection indices are developed here for a representative Brayton cycle turbocomponent, the compressor, and a representative heat transfer component, the recuperator. Especially at low power levels, these selection indices indicate substantial advantages associated with use of helium-xenon gas mixtures. Such binary inert-gas working fluids provide outstandingly low Prandtl numbers along with variable molecular weights to meet turbomachinery design requirements at various power levels. Author

N68-17804 Centre National de la Recherche Scientifique, Paris (France).
LIMITATIONS OF SOLAR COLLECTORS FOR CONVERTERS [LIMITATIONS DES COLLECTEURS SOLAIRES POUR CONVERTISSEURS]
F. Trombe and E. Le Grives *In* AGARD Combust. and Propulsion 1967 p 279–314 refs Prepared jointly with Office Natl. d'Etudes et de Rech. Aerospatiales, Paris

Research on solar energy collectors and receivers for space applications. Review of various concentrator concepts and definition of receiver configurations leading to most promising performances. Analysis of main factors affecting efficiency (geometrical perfection, optical qualities, structural rigidity, response to meteorite impacts, etc.), and receiver efficiency (absorption characteristics, surface radiation...) Author

N68-17805 Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
THERMODYNAMICS OF THERMIONIC ENERGY CONVERSION
W. B. Nottingham *In* AGARD Combust. and Propulsion 1967 p 317–335 refs (See N68-17793 08-03)

The contribution made to the understanding of thermionic energy conversion through thermodynamics is an example of one of the principal applications of this scientific discipline. First, it shows the broad outline of possibility and its bounds. It yields numerical results where details are not available. The next step toward the achievement of the practical application of the principle of energy conversion through thermionics demands a detailed understanding of many phenomena related to electron physics. A few of these may be enumerated as (1) properties of the thermionic emitter, (2) properties of the electron collector, and (3) ionization and excitation of gas (cesium) in the interelectrode space. Cesium vapor is most helpful as a substance in converter technology, since it adsorbs on refractory metal emitters such as tungsten or rhenium to lower the work-function and thus permits the emission of a high electron current density. Cesium is easily ionized by two methods: (1) contact with the heated emitter surface or (2) collision with high-energy electrons. The ions reduce or eliminate the space-charge limitation of the available current. The collector work-function is determined by its temperature, its base material and, most of all, by the adsorbed layer of cesium. Great names of electron physics

are associated with the development of the fundamentals required for the understanding of thermionic energy conversion. These scientists include Richardson, von Laue, Langmuir, Schottky, Franck, Hertz, Fowler, and others. Voltage-current curves demonstrate quantitatively the two principal modes of converter operation which are the "passive" and the "ignited", and provide the experimental data. The analysis of these data depends on the insight furnished through the application of thermodynamics and statistics to this area of research. Author

N68-17806 Technische Hochschule Stuttgart (West Germany). Institut fuer Gasentladungstechnik und Photoelektronik.
PHYSICAL METHODS OF INVESTIGATION APPLIED TO THERMIONIC CONVERTERS
W. Kluge, K. Bauer, and W. Bloss *In* AGARD Combust. and Propulsion 1967 p 337–344 (See N68-17793 08-03)

The efficiency, stability and lifetime of thermionic converters are defined primarily by the surface properties of the emitter and collector materials. New methods for surface investigations are described in this paper. Included are studies of emitter material properties through the measurement of work function distributions by emission microscopy, the use of measured emitter resistance along with an energy balance to give overall effective work functions, and the measurement of evaporation rates by means of a quartz oscillator microweighing apparatus. A method of measuring the collector work function distribution, using an image orthicon tube with the storage plate replaced by collector material, is described. Author

N68-17807 Compagnie Francaise Thomson–Houston, Bagneux, (France). Laboratorie de Recherches Generales.
PROPERTIES OF EMITTERS AND COLLECTORS FOR THERMIONIC CONVERTERS [PROPRIETES DES EMETTEURS ET COLLECTEURS POUR CONVERTISSEURS THERMOIONIQUES]
J. E. Picquendar and O. Cahen *In* AGARD Combust. and Propulsion 1967 p 345–355 ref In FRENCH; ENGLISH summary (See N68-17793 08-03)

Research on a thermionic converter without auxiliary electrode and using electronic emission and resonance ionization. Heterogeneous metal emitters are achieved by means of a mixture of tungsten and barium aluminate powders pressed at the bottom of a capsule; the collector is a molybdenum cylinder and a low-pressure cesium plasma is maintained between the electrodes. Tests performed with these converters promise a good efficiency source of energy operating at low temperature. Author

N68-17808 Commissariat a l'Energie Atomique, Saclay (France).
ON THE BEHAVIOR OF ENERGY CONVERSION LEFT FROM VAPOR IONIZED BY FISSION PRODUCTS [SUR UN PROCEDE DE CONVERSION D'ENERGIE A PARTIR DE VAPEUR IONISEE PAR PRODUITS DE FISSION]
Siegfried Klein and Pierre Kraus *In* AGARD Combust. and Propulsion 1967 p 357–374 refs In FRENCH; ENGLISH summary (See N68-17793 08-03)

When two electrodes maintained at different temperatures are immersed in ionized vapor, a potential difference appears between them. Tests have been performed in a nuclear reactor channel where the predominating ionizing agent is constituted by the fission products released by a thin layer of uranium oxide. Experience has shown that in this conversion process the negative charge carriers are not constituted by electrons only but also by negative ions or negative droplets. Further experimentation should permit the development of these converters. Author

N68-17811 Newcastle Univ. (England). Dept. of Chemical Engineering.
NON-EQUILIBRIUM MODES OF MHD CONVERTERS
Ian Fells *In* AGARD Combust. and Propulsion 1967 p 477–500 refs (See N68-17793 08-03)

The classical linear flow, crossed field MHD generator can be made to operate with about ten per cent conversion efficiency but has inherent defects. Probably the most serious problems stem from the high temperatures necessary to maintain the conductivity of the driver gas stream by thermal (i.e. usually equilibrium) ionization of seed material introduced into the gas stream. In open cycle systems failure of electrode and duct materials occur, and heat transfer to the magnet system causes loss of efficiency. Breakdown of the electrical insulation properties of the refractories also takes place. In closed cycle systems using a nuclear pile as heat source, the temperatures required for thermal ionization are unlikely to be realized in present or future designs of piles. A variety of approaches to the problem can be adopted. The reaction zones of hydrocarbon flames exhibit marked departure from equilibrium and, associated with this, ionization levels one million times greater than the predicted equilibrium values. This process is incompletely understood but phased combustion aimed at promoting this effect can lead to systems in which seed material is unnecessary. Oscillating combustion systems operating at both low and high frequencies lead to periodic high ionization levels with a low time averaged temperature. Combustion driven detonations can be maintained in various modes; the spinning mode seems particularly useful for MHD power generation. In addition to lowering the time averaged temperature, the operation of pulsed systems makes possible the generation of alternating rather than direct current. This type of system can be further elaborated by the design of linked cycle systems in which the conductivity generating process is linked to, but not the same as, the driving cycle. The freezing of equilibrium during expansion can lead to high conductivity at lower temperatures; such an effect is applicable to closed as well as open cycle systems. Author

N68-17812 International Research and Development Co. Ltd., Newcastle (England).
A NON-EQUILIBRIUM ELECTRON MODE FOR KILOWATT RANGE MPD SPACE POWER
I. R. McNab *In* AGARD Combust. and Propulsion 1967 p 501–515 refs (See N68-17793 08-03)

Many techniques for producing extra-thermal ionization in magnetoplasma-dynamic (MPD) generators are currently under investigation in the hope that reductions in the operating temperature of these generators will result. This is particularly important in the nuclear closed-cycle concept, which is of interest for space power systems, where the available gas temperature is limited by foreseeable nuclear reactor developments. One method of producing electron concentrations considerably greater than for thermal equilibrium is to rapidly expand the working fluid by means of a nozzle. This effect is investigated here, particular attention being paid to its influence on MPD generators in the range 10–100 kw output. Author

N68-17814 Air Force Systems Command, Wright-Patterson AFB, Ohio.
POTENTIALITIES OF DIRECT ELECTRO FLUID DYNAMIC ENERGY CONVERSION PROCESSES FOR POWER GENERATION, PART A
Hans von Ohain and Frank Wattendorf *In* AGARD Combust. and Propulsion 1967 p 541–561 refs (See N68-17793 08-03)

Two promising fields for the direct conversion of fluid dynamic energy into electrical energy are magneto-fluid dynamics (MFD) and electro-fluid dynamics (EFD). The major research effort to date has been in MFD processes, whereby the fluid dynamic energy of an electrically conductive medium in a thermodynamic cycle is transformed into electrical energy by passing through a magnetic field. The present paper is devoted to EFD conversion, whereby the fluid dynamic energy of a working medium containing ions or charged colloids is transformed into electrical energy by passing through an electrostatic field. Therefore, we see that EFD is not in

the strict sense a member of the MFD family, but that both are members of a broader family. However, we do not consider EFD as a competitor to MFD, but rather as prospective complement in the energy conversion spectrum. EFD processes are characterized by low current density and high voltage. While the power density is lower than that indicated for MFD, the power-to-weight ratio may still prove favorable, due to the lack of need for heavy magnetic equipment. Author

N68-17815 Air Force Systems Command, Wright-Patterson AFB, Ohio.
PERFORMANCE CHARACTERISTICS OF ELECTRO-FLUID DYNAMIC ENERGY CONVERSION PROCESSES EMPLOYING VISCOUS COUPLING, PART B
M[illegible]ice O. Lawson *In* AGARD Combust. and Propulsion 1967 p [illegible]3-580 refs (See N68-17793 08-03)

In this study, the performance characteristics of electro-fluid dynamic energy conversion processes employing viscous coupling between the neutral molecules and the electrically charged particles are determined; specifically, the conversion efficiency and other electro-fluid dynamic performance values, including the effects of the physical properties of the working medium, the influence of geometric parameters, and scaling. Author

N68-17816 Air Force Systems Command, Wright-Patterson AFB, Ohio.
PERFORMANCE CHARACTERISTICS OF ELECTRO-BALLISTIC GENERATORS, PART C
Seigfried Hasinger *In* AGARD Combust. and Propulsion 1967 p 581-601 refs (See N68-17793 08-03)

For the stubby type particle beam, the typical electric field pattern is essentially that which exists between two infinite plane parallel electrodes. Space charge effects limit the electric power density in this case. For the slender type beam, the presence of radial field components greatly reduces these space charge effects. However, the beam spread caused by the radial field components again limits the power density. Calculations have shown that the effects of these limitations on the generator performance are quite similar in each case. The slender beam allows a several times larger power density referred to the initial beam diameter, however, with the beam spread taken into account, the power density is correspondingly lower. Thus performance derived for the infinite plane parallel case can be considered generally characteristics for the ballistic generator. Author

N68-17817 Air Force Systems Command, Wright-Patterson AFB, Ohio.
ION GENERATION BY CORONA DISCHARGE FOR ELECTRO-FLUID ENERGY CONVERSION PROCESSES, PART D
Maurice O. Lawson *In* AGARD Combust. and Propulsion 1967 p 603-612 refs (See N68-17793 08-03)

Corona discharge configurations are presented and research results are discussed. These configurations enable simultaneous employment of more than one working medium (e.g., gas and vapor for the formation of charged colloids). Also, these electrode configurations do not require an electrical power input for the ion generation, rather, the ionization energy is extracted from the available fluid dynamic energy of the working medium. Theoretical approaches and numerical calculations determining the unipolar ion current as functions of pressure, speed, ion or colloid mobility, physical properties of the working medium, and geometric parameters including geometric scaling are presented and compared with the results of an experimental investigation. Author

N68-17818 Air Force Systems Command, Wright-Patterson AFB, Ohio.
EXPERIMENTAL TECHNIQUES IN ELECTRO FLUID DYNAMIC ENERGY CONVERSION RESEARCH, PART E
Michael Hawes *In* AGARD Combust. and Propulsion 1967 p 613-630 (See N68-17793 08-03)

The purpose of this study is to discuss experimental equipment and testing methods for electro-fluid dynamic power generation. The major topics of experimental research which are under study are as follows: (1) Closed-cycle or simulated closed-cycle operation. (Included are investigations on fluid-dynamic energy transfer from a supersonic jet of high molecular weight to a recirculating gas of low molecular weight; the mass flow of the supersonic jet being small in comparison to that of the recirculating gas.) (2) Methods of generation of ions or charged colloids of one polarity employing corona discharge. (3) Effects of the geometric configuration of the conversion section and determination of scaling characteristics. (4) Effects of variation in pressure in the conversion section. (5) Equipment and instrumentation for high voltage, low current, power measurements. These research topics influenced the design of the major components of the test apparatus and the testing methods which will be described in this paper. Author

N68-17819 Politechnico di Torino (Italy).
THERMODYNAMICS OF THERMOELECTRIC CONVERSION
V. Ferro *In* AGARD Combust. and Propulsion 1967 p 633-649 refs (See N68-17793 08-03)

After an examination of the experimental thermoelectric phenomena, their interpretation and correlation is made, according to the thermodynamic theory of irreversible processes. The case is then considered of an ideal thermoelectric generator, operating at optimum efficiency or at maximum electric power output conditions. Author

N68-17820 Advisory Group for Aerospace Research and Development, Paris (France).
HIGH-TEMPERATURE THERMOELECTRIC MATERIAL LIMITATIONS
C. M. Kelley and G. C. Szego *In its* Combust. and Propulsion 1967 p 651-677 refs (See N68-17793 08-03)

The characteristics of materials set many limits on their use in thermoelectric generators, the limiting factors varying in importance from one material to another. The Seebeck generator demands an extrinsic or mixed valence semiconductor. All semiconductors are limited by vapor or decomposition pressure at sufficiently high temperatures. This may be roughly estimated from the heat and entropy of vaporization, related in turn to structure and bond strength. The relation of bond strength to band gap is very approximate as presently known. Certain mixed valence semiconductors have shown adequate thermoelectric properties in the liquid state. The modules are most frequently limited by the mechanical stability of the contacts. Spring loading for high-temperature application requires some device complications. Radiative heat transfer need not be a serious problem below 1800°K. Above this temperature it may seriously impair efficiency. Because of the limited range of peak performance of individual materials, efficient devices will require graded materials or some degree of staging. At high temperatures the materials stability problem will force this to be staging. Over-all it appears that thermoelectric devices may be ultimately developed to operate at temperatures as high as 2000°K. Author

N68-17821 Admiralty Materials Lab., Poole (England).
FUEL CELL REACTANT PROPERTIES
R. G. H. Watson *In* AGARD Combust. and Propulsion 1967 p 681-707 refs (See N68-17793 08-03)

The fuel cell is considered as a chemical energy converter and the components which contribute to its important dimensions are discussed. The performance of the fuel cell system is related to the properties of its reacting components and the contribution they make to the various sources of energy loss. The values of some of these properties are readily accessible, such as the density and energy content of a fuel, which help to determine the

maximum specific energy content of a fuel cell system. Other properties, which related to energy losses, and determine cell efficiency from which the actual specific energy content is determined, may be a function of a particular cell design. For instance the amount of polarization due to slow fuel electrode reaction will involve a wide range of properties including those of electrode and fuel materials, at the cell conditions used. The reactant properties that are useful in fuel cell system design are derived in this discussion and concern the fuel, oxidant and exhaust products, and the electrodes and electrolyte. Appropriate values are tabulated and used to illustrate factors in cell design. Areas of apparent ignorance are discussed in relation to the need for further work. Author

N68-17824 Western Reserve Univ., Cleveland, Ohio.
KINETIC FACTORS IN FUEL CELL SYSTEMS: THE OXYGEN ELECTRODE
Ernest Yeager and Akiya Kozawa *In* AGARD Combust. and Propulsion 1967 p 769–793 refs (See N68-17793 08-03)

The oxygen electrode occupies a unique position with respect to fuel cells since it is the cathode of virtually all practical fuel cell systems. Experimental studies of the reduction of oxygen on porous carbon and metal electrodes of the types used as cathodes in aqueous fuel cells support the conclusion that the reduction proceeds through a peroxide intermediate. Significant concentrations of peroxide may accumulate in the solution adjacent to the cathode surface in operation at higher current densities. While the reduction of molecular oxygen to peroxide in alkaline solutions is characterized by relatively low polarization on most cathodes in aqueous low-temperature fuel cells, the subsequent reduction of the peroxide usually is very irreversible. An immediate consequence is that most low-temperature fuel cells, even at low current densities, operate at substantially less than the cell voltage predicted thermodynamically on the basis of the complete four-electron reduction of oxygen. The results of various studies of the oxygen-peroxide couple on carbon, graphite, lithiated nickel oxide, and platinum are summarized with emphasis on the dependence of the results on electrode composition, surface preparation, pH, and electrolyte composition. Some of the implications of these fundamental studies in the optimization of oxygen cathodes for aqueous fuel cells are discussed. Author

N68-17825 General Motors Corp., Dayton, Ohio. Allison Div.
THERMALLY REGENERATIVE FUEL CELLS
R. E. Henderson *In* AGARD Combust. and Propulsion 1967 p 795–809 refs (See N68-17793 08-03)

The thermally regenerative fuel cell is discussed in terms of modes of regeneration. Electrothermal as well as thermal regeneration schemes are described. The thermodynamic cycle is analyzed from the standpoint of reversible thermodynamics. A limiting efficiency is thereby calculated. Certain irreversible steps such as the voltage drop at the fuel cell and heat exchanger inefficiencies are considered from the standpoint of cycle efficiency. A practical system, namely, the K–Hg system is discussed in light of fuel cell data and boiler separator data. Space power system weights for such a system are estimated on the basis of this data. The various components of such a system are itemized and discussed from the standpoint of anticipated future developments. . . Author

N68-17826* National Aeronautics and Space Administration, Washington, D. C.
THERMODYNAMICS AND APPLICATIONS OF BIOELECTROCHEMICAL ENERGY CONVERSION SYSTEMS
Michael G. Del Duca and John M. Fuscoe *In* AGARD Combust. and Propulsion 1967 p 811–839 refs (See N68-17793 08-03)

Bioelectrochemical energy conversion is the process of converting chemical free energy of biologically catalyzed reactions to electrical energy. Particular attention in the past two years has been directed to applying the results of biochemical research and development to this type of energy conversion. This paper considers these applications in a state-of-the-art review and presents a synopsis of suggested applications, ranging from the use of bioelectric currents to identify toxic materials and power human implanted cardiac pacemakers, to the generation of electric power in remote areas of the world. Author

N68-17828 Compagnie Generale de Telegraphie Sans Fil, Puteaux (France). Centre de Recherches Physico-Chimiques.
PHOTO-VOLTAIC CELLS WITH CONCENTRATORS [CELLULES PHOTO VOLTAIEQUES AVEC CONCENTRATEURS]
Pierre Leclerc *In* AGARD Combust. and Propulsion 1967 p 863–871 (See N68-17793 08-03)

Reported is the effect of development and operational parameters of a photo-diode on its photovoltaic efficiency. Investigation of the effect of the series resistance on generator efficiency and of possible means of improving cell performance. Author

N68-17829 Laboratoire Central des Industries Electriques (France).
EFFECT OF A THERMOPHOTOVOLTAIC CONVERTER [REALISATION D'UN CONVERTISSEUR THERMOPHOTOVOLTAIEQUE]
A. Fortini, Ph. Bauduin, and P. Sibillot *In* AGARD Combust. and Propulsion 1967 p 873–896 refs (See N68-17793 08-03)

Following a brief survey of the basic theory for the photovoltaic effect, a theoretical analysis is made of the influence of geometrical and electrical parameters defining a photovoltaic cell on the conversion efficiency for the conversion of luminous energy into electrical power. Study of spectral adaptation of the cell. Theoretical predictions and experimental data are compared. Author

N68-17830 Massachusetts Inst. of Tech., Cambridge.
P–I–N STRUCTURES FOR CONTROLLED SPECTRUM PHOTOVOLTAIC CONVERTERS
David C. White and Richard J. Schwartz *In* AGARD Combust. and Propulsion 1967 p 897–922 refs (See N68-17793 08-03)

Improved efficiency in the photovoltaic conversion of radiant to electrical energy through the use of radiant energy sources with spectra matched to the electronic energy gap of the junction material was proposed by Pierre Aigrain in 1961. Investigation of systems for the control of the spectrum emitted from the source, the control of the transmitted spectra by selective filters, and the design of cells matched to the resulting spectrum have been undertaken in several laboratories since that date. The major activity has centered around 1500°C sources and germanium p–n junction cells. The factors to be considered in the design of such systems are: (1) Radiant source characteristics, (2) Spectral modification through the use of selective filters and reflectors, (3) Collection efficiency of the p–n junction, (4) The internal dissipation of energy due to series resistance within the cell, (5) The intensity of incident radiation required for efficient operation of the photovoltaic device. Considering the above factors an edge-irradiated P–I–N structure is analyzed and marked advantages are found because of higher output voltages, reduced series resistance, and improved collection efficiencies. This type of structure also possesses potential advantages for the conversion of high energy particles to electrical energy. Author

N68-17843# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION AND CALCULATION OF AXIAL-TURBINE STAGES

M. Ye. Deych and B. M. Troyanovskiy 18 Apr. 1967 600 p refs Transl. into ENGLISH of the book "Issledovaniya i Raschety Stupeney Osevykh Turbin" Moscow, Izd. Mashinostr., 1964 p 1–627
(FTD-MT-67-409; AD-663871)

The book examines methods and results of experimental investigation of turbine lattices and stages, methods of thermal and aerodynamic calculation, and design of stages with axial gas (steam) flow. Great attention is given to regulation stages of various types and the intermediate and final stages of gas and steam turbines. The effect of moisture on the through stage is considered. TAB

N68-18044*# General Electric Co., Cincinnati, Ohio.
TWO-STAGE POTASSIUM TEST TURBINE. VOLUME 3: TEST FACILITIES
S. E. Eckard Washington NASA Feb. 1968 199 p refs
(Contract NAS5-1143)
(NASA-CR-924, V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A detailed description of the two phase potassium test facility is presented. Pertinent information on operating procedures and problems is disclosed. The potassium containment piping and component hardware in the test facility were fabricated of Type 316 stainless steel. The facility was designed to produce potassium vapor up to 1600°F at 3.5 lb/sec flowrate. Maximum obtainable vapor temperature was 1587°F. The test facility was designed for Rankine cycle testing of a two-stage potassium vapor turbine. More than 2000 hours of turbine testing were completed at 1500°F turbine inlet temperature. Also thermodynamic properties of potassium vapor were experimentally investigated by flowing potassium vapor through a large convergent–divergent nozzle prior to turbine testing. Author

N68-18054# Naval Research Lab., Washington, D. C.
INCREASING THE DISCHARGE CAPACITY OF A SILVER OXIDE ELECTRODE BY CHARGING WITH 60-CYCLE ASYMMETRIC AC Interim Report
C. P. Wales 7 Nov. 1967 21 p refs
(NRL-6619; AD-663551)

The discharge capacity of sintered silver electrodes used in storage batteries was improved 40 to 50% when the prior charge was made by an alternating, rather than constant, current. Commercial Ag-Zn cells, under the same conditions, gave capacity increases of 15 to 25%. This improvement was obtained by charging the cells with 60-cps asymmetric ac, composed of two opposing half-wave currents 180 degrees out of phase and unequal in amplitude, as compared with charging by a constant current, both being at the 20-hr rate in 35% KOH at 25C. Capacity depended on the proportion of charge and discharge components of the ac. Capacity improvements were smaller when net charge current was set at the 6-hr rate, when charge current was composed of 60-cps half-wave reverse current superimposed on constant charge current, or when the KOH concentration was increased. No significant improvement occurred when the charge with reverse current followed a series of discharges at the 1-hr rate. Author (TAB)

N68-18065*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LOW INPUT VOLTAGE CONVERSION REGULATION FROM UNCONVENTIONAL PRIMARY AND SECONDARY SOURCES
Edward R. Pasciutti Jan. 1968 55 p refs
(NASA-TM-X-63118; X-716-68-49) CFSTI: HC $3.00/MF $0.65 CSCL 10B

This paper presents the principal results obtained from study and circuit development in the area of low input voltage conversion-regulation (LIVCR) from unconventional primary (RTG's) and secondary (battery) sources. An analysis was made of the source, converter, and load interrelationships for power-limited primary sources and low impedance secondary sources. A new concept and implementation of a circuit technique to improve low input voltage inverter crossover reliability, efficiency, and source ripple, by optimizing inverter full-cycle base driving conditions was developed. A configurational current feedback driven inverter approach which protects against output transformer saturation destructive current surges was developed which has important use for low impedance source LIVCR applications. To confirm the analysis, applications demonstrating the design approaches developed are presented in the paper along with waveform and numerical data. Author

N68-18186*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A JET PUMP CAVITATION PREDICTION PARAMETER
Nelson L. Sanger Washington 1968 7 p refs To be presented at ASME Fluids Eng. Conf., Philadelphia, 6 May 1968
(NASA-TM-X-52417) CFSTI: HC $3.00/MF $0.65 CSCL 10B

A parameter which predicts jet pump headrise deterioration due to cavitation is described and compared with existing methods of prediction. The cavitation prediction parameter correlated jet pump cavitation data from two different experimental investigations. Its use appears justified over a wide range of spacings of the nozzle exit from the throat entrance. R.N.A.

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N68-17219# Brookhaven National Lab., Upton, N. Y.
LIGHT INDUCED REACTIONS IN CHROMATIUM CHROMATOPHORES UNDER CONTROLLED REDOX CONDITIONS
M. A. Cusanovich (Calif. Univ., La Jolla), R. G. Bartsch (Calif. Univ., La Jolla), and J. M. Olson 1967 19 p refs Presented at the Conf. on Comp. Biochem. and Biophys. of Photosynthesis, Hakone, Japan, 12–15 Aug. 1967
(BNL-11684; CONF-670816-2) CFSTI: HC $3.00/MF $0.65

Light-induced reactions of cytochromes in Chromatium were studied in relation to bacterial photosynthesis. It was found that many of the reactions of the Chromatium could be duplicated with chromatophores and that individual reaction components could be more easily studied than was feasible with the whole cell. NSA

N68-17228# Florida Univ., Gainesville. Dept. of Pathology.
THE TOXICOLOGY OF NICKEL CARBONYL
F. William Sunderman, Jr. 1 Jul. 1967 10 p refs
(Contract AT(40-1)-3461)
(ORO-3461-9; AT(40-1)-3461-9) CFSTI: HC $3.00/MF $0.65

Summaries are presented of investigations concerned with ultrastructural and histochemical studies of the alveolar reaction to nickel carbonyl; inhibition of cortisone induction of hepatic tryptophan oxygenase by nickel carbonyl; nickel carbonyl inhibition of phenobarbital induction of hepatic cytochrome P-450; effect of nickel carbonyl upon hepatic and pulmonary aminopyrine demethylase; nickel carbonyl inhibition of RNA polymerase activity in hepatic nuclei; metabolism of ^{63}Ni-labeled carbonyl, measurement of serum nickel; studies of carcinogenesis following parenteral injection of nickel carbonyl; measurement of Cu and Tl in biological materials by atomic absorption spectrometry; electrophoretic fractionation of serum proteins in hepatic diseases; and analysis of blood ethanol by gas chromatography. NSA

N68-17247*# Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

REMOTE SENSING IMPLICATIONS OF CHANGES IN PHYSIOLOGIC STRUCTURE AND FUNCTION OF TREE SEEDLINGS UNDER MOISTURE STRESS

Frederick P. Weber and Charles E. Olson, Jr. (Mich. Univ.) 30 Sep. 1967 67 p refs

(NASA Order R-09-038-002)

(NASA-CR-93175; APR-1) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Changes in reflection and emission characteristics of coniferous and broadleaved foliage on tree seedlings subjected to varying degrees of moisture stress were studied under greenhouse conditions. Moisture stress in the foliage was measured by a Scholander hydrostatic pressure chamber. A heater source probe and detector, inserted into the active xylem, measured the rate that water was translocated upward in trees. An infrared filtered radiometer measured changes in thermal response under various solar energy inputs. The level of water stress during leaf formation was found to exert a greater influence on foliar reflectance than the level of water stress at the time the reflectance measurements were made. Pine foliage affected by moisture shortage underwent structural changes as a result of physiologic stress. However, these changes did not alter the spectral signature of foliage enough to permit pre-visual detection of moisture stress. Water loss did not affect reflectance directly except in the region of the infrared water absorption bands. R.N.A.

N68-17295*# National Aeronautics and Space Administration, Washington, D. C.

BIBLIOGRAPHY ON AEROSPACE MEDICINE AND BIOASTRONAUTICS, 1967

L. I. Boreva, comp. and E. M. Panova, comp. Feb. 1968 34 p refs Transl. into ENGLISH of the Russian Doc. "Ukazatel'literatury Aviakosmicheskaya Meditsina i Bioastronavtika 1967" Moscow, 1967 47 p Presented at the 18th Congr. of the Intern. Astron. Federation, Belgrade, 25–30 Sep. 1967

(NASA-TT-F-11403) CFSTI: HC $3.00/MF $0.65 CSCL 06S

An annotated bibliography concerned with aerospace medicine and bioastronautics is presented. Cited are such areas as general physiology, the physiology of the cardiovascular system, vestibular reactions, environmental and stress factors, hypodynamia, hypoxia, irradiation and radiation, toxicology, in-flight medical examinations, life support systems, and biochemistry. C.T.C.

N68-17370*# AiResearch Mfg. Co., Los Angeles, Calif.

METABOLIC DEMAND DURING MAN'S LUNAR ACTIVITY IN SPACE SUITS

E. C. Wortz *In* NASA. Marshall Space Flight Center 5th Ann. Meeting Working Group on Extraterrest. Resources 3 Mar. 1967 p 219–222 refs (See N68-17350 08-30)

Experiments were performed under reduced gravity simulation with the subjects walking and conducting upper torso work and calisthenics. It was found that metabolic rates during walking will be lower on the lunar surface than on the earth but that they will be higher for upper-torso work. Upper-torso tasks may be impossible to perform without restraints. The calisthenics produced no change in metabolic rate. N.E.N.

N68-17378*# California Univ., Berkeley. Forestry Remote Sensing Lab.

THE DEVELOPMENT OF SPECTRO-SIGNATURE INDICATORS OF ROOT DISEASE ON LARGE FOREST AREAS Annual Progress Report

John F. Wear 30 Sep. 1967 27 p refs

(NASA Order R-09-038-002)

(NASA-CR-93186) CFSTI: HC $3.00/MF $0.65 CSCL 02F

Remote sensing research was continued in an effort to discriminate between healthy and *Poria weirii* infected Douglas-fir trees. Promising results were obtained this year in the thermal infrared band of the electromagnetic spectrum. Spectrometric tests conducted in the visible and near infrared bands indicate that properly selected black-and-white film-filter combinations have a high probability for separating healthy trees both from diseased trees without visible crown symptoms and from diseased trees with visible crown symptoms. Foliage samples were analyzed from 45 trees, representing three tree condition classes, three stand-age classes, and three seasons of collection. Author

N68-17408*# Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.

THE USE OF MULTISPECTRAL SENSING TECHNIQUES TO DETECT PONDEROSA PINE TREES UNDER STRESS FROM INSECT OR PATHOGENIC ORGANISMS

R. C. Heller, R. C. Aldrich, W. F. McCambridge, and F. P. Weber 30 Sep. 1967 73 p refs

(NASA Order R-09-038-002)

(NASA-CR-93173; APR-2) CFSTI: HC $3.00/MF $0.65 CSCL 02F

Both ground and airborne operations were conducted to identify the likeliest sensors available to foresters to detect early tree stress. Aerial photography (color and false color) was taken at five periods (October 1966, May, June, July and August 1967) over six infestation centers to capture the changes in foliage coloration. Optical-mechanical scanning imagery was obtained in three wavelengths (2.0–2.6, 4.5–5.5, and 8.0–14.0 microns) over a three-day period in June 1967. Better ground instrumentation was developed this season for measuring sap flow, emitted foliage temperature, and meteorological conditions. A promising new device (Scholander bomb) measured highly significant differences in needle moisture tension between healthy and stressed foliage. Foliage discoloration rates of all 204 infested trees were established by comparison with Munsell cards. Ground Munsell notations of infested foliage were very similar to Munsell notations of the tree images in color aerial transparencies; however, Munsell notations on 35 mm. ground photography showed less agreement with either of the above. Author

N68-17466# Royal Air Force, Farnborough (England). Inst. of Aviation Medicine.

PHYSIOLOGICAL AND PSYCHOLOGICAL MEASUREMENTS OF PILOT WORKLOAD

F. G. Cumming and K. G. Corkindale *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 649–657 refs (See N68-17460 08-02)

The various methods used in measuring a pilot's workload and their limitations are discussed. These include measurement of the operator's performance, assessment of operator behavior, the operator's subjective assessment of the task, an observer's assessment of the operator's performance, measurement of the operator's response to addition tasks performed concurrently with his primary task, and the operator's psycho-physiological response in the task situation. Physiological measurements of pilot workload are shown to be capable of providing useful data in situations where other methods of assessment are likely to be either dangerous or impracticable. If only one measure is to be used then heart rate recording has the advantages of ease of recording and apparent sensitivity to changes in task loading. However, with a single measure the methodological finding of the need to use each subject as his own control must be adopted. Several physiological measurements should be taken so that relatively small differences in workload can be detected. R.N.A.

N68-17545# Defence Research Board, Ottawa (Ontario).
CONJUGATE BILATERAL FUNCTIONING OF THE VESTIBULAR APPARATUS (HOGYES-BEKHTEREV PRINCIPLE OF INTERCENTRAL EQUILIBRATION)
G. I. Gorgiladze Jan. 1968 11 p refs Transl. into ENGLISH from Fiziol. Zh. SSSR (Moscow), v. 52, no. 6, 1966 p 669–676 (T-490-R)

Electrocorticograms (ECoG) were taken on 33 adult cats to study the vestibular excitation occurring when the labyrinth is cathodically or anodically polarized. The results of polarization of one and two labyrinths with direct current is discussed, along with an explanation of why the stream of impulses, when both labyrinths are cathodically excited, fail to show its activating effect on the ECoG. To investigate the blocking of the vestibular excitation outside the reticular formation, a study was made of labyrinth polarization reactions of single neutrons in the vestibular nuclei of the medulla oblongata. It was determined that the activity of the right and left vestibular nuclei upon polarization of one labyrinth are reciprocal in character, and the ECoG activation reaction occurs every time the equilibrium between the right and left vestibular nuclei is disturbed. It is concluded that the effect of the vestibular apparatus on the cortex depends on disruption of the dynamic equilibrim that exists, between the vestibular nuclei of the two sides.
B.S.D.

N68-17574# Advisory Group for Aerospace Research and Development, Paris (France).
ELECTROENCEPHALOGRAPHY IN AEROSPACE MEDICINE
P. M. van Wulfften Palthe (Natl. Aeromed. Center, Soesterberg, Netherlands) 1967 189 p refs
(AGARDograph-110) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. THE USE OF THE ELECTROENCEPHALOGRAM (EEG) IN AVIATION MEDICINE P. J. O'Connor p 1–12 (See N68-17575 08-04)

2. THE USE AND ABUSE OF THE EEG IN AIRCREW SELECTION J. W. Scott p 13–23 refs (See N68-17576 08-04)

3. THE USE AND ABUSE OF ELECTROENCEPHALOGRAPHY IN CLINICAL MEDICINE W. B. Matthews p 25–32 refs (See N68-17577 08-04)

4. MEANING AND VALUE OF ELECTROENCEPHALOGRAPHY IN AERONAUTICAL MEDICINE C. Blance, E. Lafontaine, and R. Laplane p 33–61 refs (See N68-17578 08-04)

5. PRINCIPLES AND METHODS OF APPLICATION OF ELECTROENCEPHALOGRAPHY IN AVIATION MEDICINE C. Blanc, E. Lafontaine, and R. Laplane p 63–73 refs (See N68-17579 08-04)

6. ELECTROENCEPHALOGRAPHIC EXAMINATION IN THE FRAMEWORK OF FITNESS EXAMINATIONS FOR THE AVIATION FLYING PERSONNEL A. J. M. Raboutet and G. Soussen p 75–91 refs (See N68-17580 08-04)

7. FLICKER AS A HELICOPTER PILOT PROBLEM: USE OF PHOTIC STIMULATION AND EEG AS SCREENING TECHNIQUES L. C. Johnson p 93–109 refs (See N68-17581 08-04)

8. THE INFLUENCE OF FLICKER ON THE LEVEL OF CONSCIOUSNESS G. J. Puister p 111–121 ref (See N68-17582 08-04)

9. THE ELECTROENCEPHALOGRAM IN THE SELECTION OF FLYING PERSONNEL G. J. Puister p 123–133 refs (See N68-17583 08-04)

10. ELECTROENCEPHALOGRAPHIC CHANGES IN HUMAN SUBJECTS DURING BLACKOUT PRODUCED BY POSITIVE ACCELERATION R. D. Squires, R. E. Jensen, W. C. Sipple, and J. J. Gordon p 135–152 refs (See N68-17584 08-04)

11. ELECTROENCEPHALOGRAPHY AND FLUCTUATIONS IN THE LEVEL OF CONSCIOUSNESS P. M. van Wulfften Palthe p 153–190 refs (See N68-17585 08-04)

12. ELECTROENCEPHALOGRAPHS OF AVIATORS IN RELATION TO AIRCRAFT ACCIDENTS AND ATTRITION FROM FLIGHT TRAINING H. W. Ades p 191–193 (See N68-17586 08-04)

N68-17575# Royal Air Force, Farnborough (England). Central Medical Establishment.
THE USE OF ELECTROENCEPHALOGRAM (EEG) IN AVIATION MEDICINE
P. J. O'Connor *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 1–12 (See N68-17574 08-04)

A routine electroencephalogram (EEG) is recommended for all aviation candidates to disqualify men with grossly epileptic records and to have a means of comparing tracings in the event of a brain disorder that subsequantly occurs in the service. The EEG was found particularly useful in the diagnosis of disturbances in consciousness and, less frequently, of other disturbances in brain function and structure. Common causes of consciousness disturbance are discussed, including syncope, epilepsy, excess G force lack of oxygen, carbon monoxide poisoning, hypoglycemia, decompression, cerebral catastrophes, and psychological disorders.
M.W.R.

N68-17576# Toronto Univ. (Ontario).
THE USE AND ABUSE OF THE EEG IN AIRCREW SELECTION
John W. Scott *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 13–23 refs (See N68-17574 08-04)

The Royal Canadian Air Force's policy of giving electroencephalograms to all aircrew candidates is noted, and a long-term study is being made to determine the correlation of irregularities in EEG patterns with subsequent success in flight training and actual flying. Major objectives of using the EEG are to recognize men who are liable to suffer brief periods of unconsciousness, to monitor cerebral insufficiency produced by physiological stresses, and to assess the capabilities of pilots being returned to duty following illnesses and injuries involving the nervous system. While the EEG has provided a useful clinical tool in detecting epilepsy and organic cerebral lesions and monitoring cerebral function during stress, it does not help in identifying the personality and emotional traits that produce good pilots.
M.W.R.

N68-17577# Derbyshire Royal Infirmary, Derby (England).
THE USE AND ABUSE OF ELECTROENCEPHALOGRAPHY IN CLINICAL MEDICINE
W. B. Matthews *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 25–32 refs (See N68-17574 08-04)

A common-sense approach to the use of electroencephalography in clinical medicine is stressed; as is the need for experimental efforts, cooperative programs between physiologist and clinician, and the need for more trained personnel. Questions asked of the EEG are discussed, including those concerned with epilepsy, temporal lobectomies, intracranial space lesions, and insanity.
M.W.R.

N68-17578# Compagnie Nationale Air France, Paris (France)
MEANING AND VALUE OF ELECTROENCEPHALOGRAPHY IN AERONAUTICAL MEDICINE
C. Blanc, E. Lafontaine, and R. Laplane *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 33–61 refs (See N68-17574 08-04)

Results are reported of ten years' experience covering 8,000 electroencephalographic recordings made on subjects belonging to the Air France Cabin Staff. Criteria of the conventional EEG tracings were analyzed by the use of a longitudinal classification distinguishing the "evolutive tracings" and the "stationary tracings".

In about 100 monographic studies, evolutive correlations appear between the psycho-affective and psychophysiological factors, and the electrical disturbances. Major EEG anomalies (generalized paroxysms, left temporal foci, photo-sensitivity) are transitorily observed in the course of anxiety neurosis, neurotic depressions, and psychosomatic syndromes. The extent of disorders in the hypnotic function is shown in the genesis of the occasional disturbances in EEG tracings with normal subjects. Certain electrical patterns observed on recruitment tracings seem to have an anticipatory value, a predictive significance necessitating an exploration of the personality by a psychiatric examination. The importance of the EEG with subjects presenting antecedents of cranial traumatisms without clinical after-effects, is also stressed. Author

N68-17579# Compagnie Nationale Air France, Paris (France).
PRINCIPLES AND METHODS OF APPLICATION OF ELECTROENCEPHALOGRAPHY IN AVIATION MEDICINE
C. Blanc, E. Lafontaine, and R. Laplane *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 63–73 refs (See N68-17574 08-04)

Of 10,000 electroencephalogram recordings made over the past 10 years, 8,000 were of cabin staff, 950 of pilots, and 1,050 of ground staff personnel. Subclinical disturbances observed in 35% of the cabin staff and 20% of the pilots appear to be correlated with psychological, psychiatric, or psychophysiological factors in many instances rather than with potential epilepsies. The need for an EEG reference tracing at the time other selection tests are given aircrew personnel is stressed and discussed in terms of policy of Air France. The occurrence of EEG anomalies in pilots in considered the bases for refection, since the meaning of such anomalies cannot always be determined. M.W.R.

N68-17580# Centre d'Enseignement et de Recherches de Medicine Aeronautique, Paris (France).
ELECTROENCEPHALOGRAPHIC EXAMINATION IN THE FRAMEWORK OF FITNESS EXAMINATIONS FOR THE AVIATION FLYING PERSONNEL [L'EXAMEN ELECTROENCEPHALOGRAPHIQUE DANS LE CADRE DE LA VISITE D'APTITUDE DU PERSONNEL NAVIGANT DE L'AVIATION]
A. J. M. Raboutet and G. Soussen *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 75–91 refs In FRENCH; ENGLISH summary (See N68-17574 08-04)

More than 6700 electroencephalograms made on flying personnel during the past 15 years indicate that tracings can be interpreted in three groups. Group I consists of usual or normal tracings, and comprises 80% of the total EEG's performed. Group II, with 17.5%, consists of borderline traces; and Group III, with 2.5%, represents abnormal tracings with posterior theta-delta rhythms and "spike-wave" complex. Those in the third group must be subjected to a very complete clinical and psychological examination in order to reveal the roles of fatigue, nervous tension, or recent mild infectious diseases that might cause EEG abnormalities. The role of the EEG as a complementary test is stressed, although it is noted that in 1% of the cases the mere presence of abnormal signs is sufficient to lead to a verdict of unfitness for flying duties. M.W.R.

N68-17581# Navy Medical Neuropsychiatric Research Unit, San Diego, Calif.
FLICKER AS A HELICOPTER PILOT PROBLEM: USE OF PHOTIC STIMULATION AND EEG AS SCREENING TECHNIQUES
Laverne C. Johnson *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 93–109 refs (See N68-17574 08-04)

Flicker vertigo during flight was reported as a problem for approximately one-fourth of the 102 pilots examined. Generally, flicker was described as only annoying or distracting; but, in one instance, a near accident was attributed to flicker. For the experienced helicopter pilot, photic stimulation did not appear to be a useful device to detect those who would show abnormal EEG activity during flicker. Photic stimulation, however, did identify pilots who had subjective feelings of discomfort during the flickering light; and in one-fourth of the sample, degree of alertness was markedly affected during flicker. Neither baseline EEG data nor induced photic changes in the EEG pattern showed a clearcut relationship to flight performance or to cognitive motor functioning in the laboratory. The complex problem of the relationship of normal and paroxsymal EEG activity to motor-cognitive functioning is discussed. Author

N68-17582# National Aeromedical Center, Soesterberg (Netherlands).
THE INFLUENCE OF FLICKER ON THE LEVEL OF CONSCIOUSNESS
G. J. Puister *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 111–121 ref (See N68-17574 08-04)

A lowering of the level of consciousness caused by flicker could not be proved by using the Bourdon–Wiersma Stipple Test in a small population of young healthy subjects. The influence of hyperventialtion in sensitive subjects of a comparable group could be measured with the stipple test and shown to be related to fluctuations in the level of consciousness by an electroencephalogram. However, it is pointed out that an identical EEG can have a different meaning. Author

N68-17583# National Aeromedical Center, Soesterberg (Netherlands).
THE ELECTROENCEPHALOGRAM IN THE SELECTION OF FLYING PERSONNEL
G. J. Puister *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 123–133 refs (See N68-17574 08-04)

The EEG of the large majority of well-known civil pilots showed a monorhythmic alpha. A small majority had a flat, reduced voltage or a polyrythmic EEG without alpha activity. Their professional performance was almost always considered as "substandard". Flight engineers, on the other hand, had an EEG which showed almost no monorthythmic alpah. The large majoirty who had a similar EEG were considered better than the others. In the case of trainee pilots, an immaturity factor is probably responsible for their lower standard of professional performance as well as for the fact that their EEG's show no alpha activity. The psychological analyses of the personality structure of flight engineers would seem to indicate a correlation between the predominance of a polyrhythmic EEG and outstanding technical ability (mechanical comprehension tests). The EEG may constitute a factor in the selection of aircrew. A flat or polyrhythmic EEG is an unfavorable sign in the case of a future pilot; and EEG which shows no alpha activity is an advantage when predicting the career of a flight engineer. Author

N68-17584# Naval Air Development Center, Johnsville, Pa.
ELECTROENCEPHALOGRAPHIC CHANGES IN HUMAN SUBJECTS DURING BLACKOUT PRODUCED BY POSITIVE ACCELERATION
R. D. Squires, R. E. Jenson, W. C. Sipple, and J. J. Gordon *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 135–152 refs (See N68-17574 08-04)

Analysis of the taped EEG signals from 13 men was accomplished by a 14-channel, continuous frequency analyzer using bandpass filters, with voltage outputs rectified and passed through a smoothing filter in order to obtain a direct current voltage proportional to the amplitude of the frequency band passed by each filter. Frequency analysis showed characteristic changes during visual greyout and blackout. The increase in beta frequencies from 16 to 36 c/s showed the same general amplitude pattern as the

acceleration profile. The lower beta frequencies, 16 to 19 c/s, had a tendency to level out or to decrease during each blackout coincident with an increase in the lower frequency components. The alpha frequencies, 8 to 13 c/s, often appeared during greyout and blackout, but sometimes disappeared during very deep blackout when bursts of high amplitude and low frequency components appeared. The best index of the level of consciousness appears to be the inverse relationship between the depth of blackout and the amplitude of EEG frequencies in the range of 5 c/s. Author

N68-17585# National Aeromedical Center, Soesterberg (Netherlands).

ELECTROENCEPHALOGRAPH AND FLUCTUATIONS IN THE LEVEL OF CONSCIOUSNESS

P. M. van Wulfften Palthe *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 153–190 refs (See N68-17574 08-04)

Isolation, silence, and restriction of mobility were imposed upon 48 subjects of different ages and occupations who were tested during a three-hour stay in a cylinder or decompression chamber. The EEG, eye movements, EKG, and respiration were recorded throughout the testing period. Vegetative functions showed a slight but constant lowering of performance, and the subjects exhibited large variations in their levels of consciousness. Studies were also made of 40 pilots and trainee pilots who were placed in an ejector seat in a cockpit simulator; and the same variations in consciousness appeared when the men were isolated. About 18% of the subjects slept for short periods, while the majority showed EEG signs of various stages of sleep from the beginning of the testing. It is concluded that electroencephalography on flying pilots is a cumbersome procedure for use as a warning system, and that the principles of galvanic skin resistance offers more promise. Music and familiar human voices were suggested as the alerting stimuli. M.W.R.

N68-17586# Naval School of Aviation Medicine, Pensacola, Fla.

ELECTROENCEPHALOGRAPHS OF AVIATORS IN RELATION TO AIRCRAFT ACCIDENTS AND ATTRITION FROM FLIGHT TRAINING

Harlow W. Ades *In* AGARD Electroencephalog. in Aerospace Med. 1967 p 191–193 (See N68-17574 08-04)

Electroencephalograms of more than 7500 naval aviator students indicate correlations that appear to relate cerebral physiology to success or failure in flight training. The 352 student aviators involved in 578 accidents while in control of an aircraft, exhibited somewhat greater EEG abnormality than a control group; and those involved in fatal accidents showed a markedly higher incidence of EEG abnormality. Incidence of EEG abnormality for students involved in two to six accidents is similar to that of those involved in fatal accidents. This summary notes that there are some indications that EEG types which go with success in training do not always correlate well with accident-free flying careers. M.W.R.

N68-17590*# Naval Air Development Center, Johnsville, Pa. Aerospace Crew Equipment Dept.

PHYSIOLOGICAL EFFECTS OF DIFFERENT OXYGEN FLOW RATES AND AMBIENT TEMPERATURES ON PRESSURE-SUITED SUBJECTS PERFORMING WORK AT ALTITUDE

Louis J. SantaMaria, David J. Horrigan, Jr., and Meredith H. Radliff 22 Dec. 1967 13 p refs

(NASA Order T-59457)

(NASA-CR-93256; NADC-AC-6708; AD-663907) CFSTI: HC $3.00/MF $0.65 CSCL 06P

In a series of tests conducted at different ambient temperatures, the physiological effects of various levels of flow rate of ventilating O2 were investigated. Pressure-suited subjects underwent moderate work stress on a bicycle ergometer in an altitude chamber maintained at 5 PSIA. The temperature and relative humidity of the ventilating O2 were maintained constant at 55F and 90-95%, respectively; the duration of the runs was fixed at 2 hours. Within the limits of the ambient temperatures and ventilating flow rates employed in this study, only slight advantages were gained by increasing flow rate, as observed in terms of the physiological measurements made in this study. Author (TAB)

N68-17682# Library of Congress, Washington, D. C. Aerospace Technology Div.

ELECTROSLEEP AND ELECTROANESTHESIA—THEORY AND CLINICAL EXPERIENCE

Arsen Iwanovsky and Christopher H. Dodge *In its* Foreign Sci. Bull., Vol. 4, No. 2, Feb. 1968 p 1–64 refs (See N68-17681 08-34)

Electrosleep and electroanesthesia in Soviet practice are discussed, and details are given on a broad range of electroneural techniques used alone or in combination with other conventional approaches in an extremely wide variety of surgical, neurological, and quasi-neurological situations. Some examples of electronic circuitry are presented to show how a therapeutic electrosleep effect may be obtained from any pulse generator having an output voltage form close to the required parameters. West German experiments on electrosleep are reported, and the theoretical and practical aspects of the method are reviewed. Documentation based on Soviet and East European clinical experience is given. Efforts of several researchers to improve upon existing techniques and to introduce new applications into the clinic and even the classroom (hypnopedia) are noted. It is pointed out that both techniques are generally regarded with skepticism in the United States, although some active theoretical research is being conducted. A reference bibliography is included. M.G.J.

N68-17684# Library of Congress, Washington, D. C. Aerospace Technology Div.

DIAGNOSTIC USE OF THE FLUORESCENT-ANTIBODY METHOD IN THE USSR

Lee Perkins *In its* Foreign Sci. Bull., Vol. 4, No. 2, Feb. 1968 p 85–101 refs (See N68-17681 08-34)

The applications of the fluorescent-antibody method are primarily medical, taxonomical, and immunological. The method has been used in the diagnosis of bacterial, rickettsial, and viral diseases. It is especially useful in the diagnosis of influenza, smallpox, mumps, polio, rabies, tickborne encephalitis, fowl plague, hog cholera, meningitis, bacterial and viral dysentery, staphylo-coccal infection, Shigella dysentery, Q-fever, and other illnesses. It is also a useful tool in the study of microbial and other antigens, cell-virus interaction, antibiotic sensitivity, biosynthesis, and taxonomy. Fluorescein and related chemicals and specialized equipment have been developed to improve the technique, lower costs, and broaden its applicability. Author

N68-17730# Yale Univ., New Haven, Conn. School of Medicine.

EFFECTS OF 1,1-DIMETHYLHYDRAZINE (UDMH) ON EVOKED CEREBRAL NEUROELECTRIC RESPONSES Final Report, Jun. 1966–Mar. 1967

W. R. Goff, Truett Allison, Y. Matsumiya, M. B. Sterman (Calif. Univ., Los Angeles), and M. D. Fairchild (Calif. Univ., Los Angeles) Wright-Patterson AFB, Ohio AMRL Sep. 1967 17 p refs Prepared for California Univ.

(Contract AF 33(615)-2822; Grant PHS-M-05288)

(AMRL-TR-67-67; AD-663764)

The neural mechanisms of UDMH intoxication were studied by analyzing changes in cortical, subcortical, and cerebellar neuroelectric potentials evoked by peripheral nerve stimulation. Results showed that the negative component of the primary somatosensory cortical evoked potential was markedly potentiated by UDMH

intoxication while the positive component of this response together with the response from the specific somatic sensory thalamic relay and from the cerebellum were unaffected. The potentiation almost always occurred in the absence of other evoked or spontaneous neuroelectric changes and preceded epileptiform seizure by several minutes. Thus it was usually the sole predictor of seizure. Motor paralysis markedly prolonged seizure onset. These results indicate the UDMH intoxication increases intracortical excitability acting primarily at axo-denritic synapses to block inhibitory post-synaptic potentials. The resulting positive sensory-motor feedback is an important element in the production of seizures. Author (TAB)

N68-17734*# California Univ., Davis.
PERIPHERAL VOLUME MEASUREMENTS AS INDICES OF PERIPHERAL CIRCULATORY FACTORS IN THE CARDIOVASCULAR ORTHOSTATIC RESPONSE Final Report
Loren D. Carlson [1967] 183 p refs
(Grant NGR-05-004-026)
(NASA-CR-93247) CFSTI: HC $3.00/MF $0.65 CSCL 06P

Three techniques of measuring changes in limb volume were evaluated: (1) limb circumference changes by a resistance transducer, (2) limb volume change by capacitance measurement, and (3) limb volume change by impedance measurement. None of the techniques seem qualified for in-flight use. Each must be used with great care in controlled laboratory experiments. Data obtained from their use with tilt table or negative pressure devices were tentative due to the possibilities of artifact. A bedrest study was conducted to evaluate the cardiovascular function following bedrest. Metabolic balance, basal and work metabolisms, fluid spaces, body composition, strength, renal function, and blood and urine composition were measured. Heart rate and blood pressure served as reference and comparative values for other tests. Both heart rates and blood pressures were higher in the evening than in the morning and neither differed in response to tilt at the two times. Negative pressure tests showed changes in heart rate and blood pressure that were similar to the tilt tests, but to a lesser degree. Leg volume increases were greater following bedrest. R.N.A.

N68-17742# Joint Publications Research Service, Washington, D. C.
SPACE BIOLOGY AND MEDICINE, VOLUME 1, NUMBER 5, 1967
9 Feb. 1968 171 p refs Transl. into ENGLISH from Komich. Biol. i Med. (Moscow), v. 1, no. 5, 1967 p 1–96
(JPRS-44299) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. COURSE OF DEVELOPMENT OF SOVIET SPACE BIOLOGY AND MEDICINE V. V. Parin and O. G. Gazenko p 1–9 (See N68-17743 08-04)

2. RESULTS AND FUTURE OF RESEARCH IN THE FIELD OF SPACE GENETICS O. G. Gazenko and G. P. Parfenov p 10–17 (See N68-17744 08-04)

3. STRUCTURAL AND FUNCTIONAL IMPAIRMENTS OF CERTAIN SYSTEMS OF THE ANIMAL BODY IN RESPONSE TO EXTREME EXPOSURES V. V. Parin and I. M. Khazen p 18–29 refs (See N68-17745 08-04)

4. MATHEMATICAL MODELING OF HEAT AND HUMIDITY VARIATION IN AIRTIGHT SPACESHIP COMPARTMENTS B. A. Adamovich, A. V. Kostetskiy, V. A. Kurochkin, and G. G. Ter-Minas'yan p 30–39 refs (See N68-17746 08-05)

5. EFFECT OF DIET CONTAINING UNICELLULAR ALGAE ON THE COMPOSITION OF ENTERIC MICROFLORA IN ANIMALS V. M. Shilov, N. N. Liz'ko, V. I. Fofanov, and N. S. Klyushkina p 40–45 refs (See N68-17747 08-04)

6. EFFECT OF TRANSVERSE ACCELERATIONS OF THE ACETYLCHOLINE CONTENT AND CHOLINESTERASE ACTIVITY OF THE BLOOD OF EXPERIMENTAL ANIMALS N. V. Korneyeva and A. S. Ushakov p 46–52 refs (See N68-17748 08-04)

7. CORRELATION OF ELECTROENCEPHALOGRAPH (EEG) SHIFTS AND THE FOOD PROCURING REFLEX OF RABBITS DURING INCREASING HYPOXIA L. V. Kalyuzhnyy, N. A. Agadzhanyan, and I. N. Zakharova p 53–66 refs (See N68-17749 08-04)

8. EXPERIENCE IN USE OF PROPHYLACTIC AND THERAPEUTIC COMPLEXES DURING REPEATED EXPOSURE TO IONIZING RADIATION M. N. Trushina p 67–76 refs (See N68-17750 08-04)

9. SOME INTERPRETATIONS OF THE BIOLOGICAL EFFECT OF CHRONIC γ-IRRADIATION A. F. Khoruzhenko, A. I. Laptev, I. G. Oreshkin, V. N. Malakhovskiy, and V. A. Rezontov p 77–85 refs (See N68-17751 08-04)

10. THE COMBINED EFFECT OF TWO-MONTH HYPOKINESIA AND RADIAL ACCELERATIONS ON THE CARDIOVASCULAR SYSTEM G. P. Mikhaylovskiy, T. V. Benevolenskaya, T. A. Petrova, I. Ya. Yakovleva, O. I. Boykova et al p 86–90 refs (See N68-17752 08-04)

11. FUNCTIONAL CHANGES IN THE NERVOUS SYSTEM AND FUNCTIONING AND CERTAIN ANALYZERS IN RESPONSE TO THE COMBINED EFFECT OF HYPOKINESIA AND RADIAL ACCELERATION T. W. Krupina, A. Ya. Tizul, N. M. Boglevskaya, B. P. Baranova, E. I. Matsnev et al p 91–99 refs (See N68-17753 08-04)

12. HUMAN BASAL METABOLISM DURING PROLONGED BEDREST B. S. Katkovskiy p 100–107 refs (See N68-17754 08-04)

13. RESULTS OF PHYSIOLOGICAL STUDIES PERFORMED IN A SLOW ROTATION CHAMBER R. R. Galle and M. D. Yemel'yanov p 108–118 refs (See N68-17755 08-04)

14. ON THE INTERACTION OF ANALYZERS DURING WEIGHTLESSNESS L. A. Kitayev-Smyk p 119–125 refs (See N68-17756 08-04)

15. CHARACTERISTICS OF REACTION OF THE HUMAN ACOUSTIC ANALYZER TO SOME SPACE FLIGHT FACTORS Yu. V. Krylov p 126–133 refs (See N68-17757 08-04)

16. BIOLOGICAL RHYTHMS AND DEVELOPMENT OF WORK AND REST REGIMES FOR COSMONAUTS F. P. Kosmolinskaya p 136–141 (See N68-17758 08-04)

17. ANNUAL MEETING OF THE ALL-UNION BOTANICAL SOCIETY L. V. Dmitriyeva p 142–143 (See N68-17759 08-04)

N68-17743# Joint Publications Research Service, Washington, D. C.
COURSE OF DEVELOPMENT OF SOVIET SPACE BIOLOGY AND MEDICINE
V. V. Parin and O. G. Gazenko *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 1–9 (See N68-17742 08-04)

Primary stages of development of Soviet space biology and medicine are reviewed. Emphasized are two major stages in development during which (1) methodological principles were devised and observational data on human responses to prolonged space flight were compiled; and (2) qualitative studies of humans and animals were made to assess physiological responses to zero gravity environments. Current Soviet research in space biology and medicine which is directed towards increasing human tolerance to various flight factors, and ensuringhigh reliability of man machine systems; is also discussed. S.C.W.

N68-17744# Joint Publications Research Service, Washington, D. C.
RESULTS AND FUTURE OF RESEARCH IN THE FIELD OF SPACE GENETICS
O. G. Gazenko and G. P. Parfenov *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 10–17 (See N68-17742 08-04)

A review of space genetics research during the period 1930 to 1967 is presented. Discussed are evolutionary trends which involved studies of the effects of cosmic ionizing radiation on

organic evolution, the biological effects of galactic cosmic radiation, and experimental studies to determine the applications of biological indexes and dosimetry during manned space flight. It is surmised that future space genetics research will be marked by an increase in the duration of spaceflights to an extent commensurate with the duration of the ontogenetic developement of multicell organisms, the duration of their reproductive period, and the lifetime of individual biological specimen. S.C.W.

N68-17745# Joint Publications Research Service, Washington, D. C.

STRUCTURAL AND FUNCTIONAL IMPAIRMENTS OF CERTAIN SYSTEMS OF THE ANIMAL BODY IN RESPONSE TO EXTREME EXPOSURES

V. V. Parin and I. M. Khazen *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 18–29 refs (See N68-17742 08-04)

Studies on structural and functional impairments of some systems of the animal body when exposed to hypoxia, accelerations, and other stress factors are reported. Results indicate that: (1) Apparent changes of the tissue structure of different systems (especially the digestive system) as well as changes of internal media can be revealed using special techniques. (2) The impairments are latent and may develop against the background of a satisfactory good state of health, the absence of significant changes in behavioral responses, and rapid recovery of vital systems (central nervous, cardiovascular and respiratory systems), thus giving evidence of a good compensatory capacity of the animal and human body. (3) The use of the function of the nerve and glandular apparatus of the digestive system as an indicator of the response of the organism to space flight stress can help in an analysis of the homeostatic mechanisms at different regulation levels. (4) Aside from the higher mechanisms of the cortical and subcortical levels, the adaptive system of an automatic control and self-control with an alternative structure appears to play a significant role. (5) A proper theoretical approach makes possible prediction of the development of physiological processes and their control, maintaining the homeostatic functions of man and ensuring his good health and performance. Author

N68-17747# Joint Publications Research Service, Washington, D. C.

EFFECT OF A DIET CONTAINING UNICELLULAR ALGAE ON THE COMPOSITION OF ENTERIC MICROFLORA IN ANIMALS

V. M. Shilov, N. N. Liz'ko, V. I. Fofanov, and N. S. Klyushkina *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 40–45 refs (See N68-17742 08-04)

The effect of diets containing different protein sources on the composition of enteric microflora was studied using white rats of two generations. Casein containing diets fed to the experimental animals decreased the number of acidophil bacteria whereas diets containing unicellular algae increased the number of spore forming anaerobic bacteria and resulted in an insignificant increase of the number of *Escherichia coli* in the feces of the first generation rats. The changes observed appear to be related to the quality of the protein in the diet. Author

N68-17748# Joint Publications Research Service, Washington, D. C.

EFFECT OF TRANSVERSE ACCELERATIONS ON THE ACETYLCHOLINE CONTENT AND CHOLINESTERASE ACTIVITY OF THE BLOOD OF EXPERIMENTAL ANIMALS

N. V. Korneyeva and A. S. Ushakov *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 46–52 refs (See N68-17742 08-04)

Reported is a study designed to determine the effects of exposure to transverse accelerations of 8 g on the acetylcholine content and cholinesterase activity of rabbit blood. Exposure produced reversible changes in the acetylcholine content. Immediately after exposure the acetylcholine content increased sharply, then gradually decreased and disappeared completely in one to three days and reached the normal level by the fifth day after exposure. Cholinesterase activity remained virtually constant, showing only a slight increase three days after exposure. Acetylcholinesterase activity rapidly decreased, one and three days after exposure. The relative volume of erythrocytes (hematocrit) revealed no changes after exposure of rabbits to accelerations. Author

N68-17749# Joint Publications Research Service, Washington, D. C.

CORRELATION OF ELECTROENCEPHALOGRAPH (EEG) SHIFTS AND THE FOOD PROCURING REFLEX OF RABBITS DURING INCREASING HYPOXIA

L. V. Kalyuzhnyy, N. A. Agadzhanyan, and I. N. Zakharova *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 53–66 refs (See N68-17742 08-04)

Experiments were carried out on unrestrained rabbits which had developed a food-procuring reflex to a rhythmic light stimulus. The animals were exposed to a low atmospheric pressure with a gradual rise of 25 m/sec. As shown by their EEG records, the function of the frontal and lateral hypothalamic parts increased at simulated altitudes of 2,000 to 3,000 m, thus promoting their reflex activity. At simulated altitudes of 5,000 to 7,000 m the rabbits exhibited generalization of rhythms of signal assimilation and their transformation in the subcortical nonspecific activating system due to the development of parabiotic phases which caused the disappearance of conditioned reflexes. At altitudes of 5,000 to 7,000, signal rhythm assimilation occurred only in the optic cortex and not in the subcortex. It is surmised that the disappearance of conditioned reflexes at altitudes of 5,000 to 7,000 m is related to excessive excitation and parabiosis of the nonspecific activating system of the brain stem resulting from hypoxia. Author

N68-17750# Joint Publications Research Service, Washington, D. C.

EXPERIENCE IN USE OF PROPHYLACTIC AND THERAPEUTIC COMPLEXES DURING REPEATED EXPOSURE TO IONIZING RADIATION

M. N. Trushina *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 67–76 refs (See N68-17742 08-04)

The purpose of this study was to test the effect of prophylactic, therapeutic, and protective complexes on dogs exposed to X-rays. The animals received 30 to 40 R four times a week, the total dose being 600 R. The therapeutic complexes included vitamins, amino acids, orotic acid, leucocytine and prednisolone, which produced a favorable effect on the clinical development of radiation sickness, promoting the survival of irradiated animals. The complexes administered for two weeks before a repeated exposure of dogs to irradiation improved the hematological indices recorded during the first two to three weeks of irradiation. The complex of vitamins and amino acids appeared to give the best therapeutic results. An application of protectors and the vitamin–amino acid complex used two weeks after irradiation alleviated the disease, thus increasing the percentage of survival of the animals tested. Author

N68-17751# Joint Publications Research Service, Washington, D. C.

SOME INTERPRETATIONS OF THE BIOLOGICAL EFFECT OF CHRONIC γ IRRADIATION

A. F. Khoruzhenko, A. I. Laptev, I. G. Oreshkin, V. N. Malakhovskiy, and V. A. Rezontov *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 77–85 refs (See N68-17742 08-04)

Rats were exposed daily to fractional Co^{60} γ-irradiation, the duration of exposure ranging from 1 to 90 days in different experiments. As the duration of exposure increased, the magnitude

of the median lethal dose increased in an asymmetrical sigmoid relation. The correlation was analyzed using the method of a quantitative expression of the radiobiological effect through dose units. On this basis it was possible to develop a model of accumulations and repair of radiation damage associated with chronic exposure to gamma rays. Results obtained are in agreement with the theory of monotonic repair of the elementary damage with a 20% level of irreversibility. As a result, the response of the animal body to chronic γ-irradiation appears similar to that of acute γ-irradiation. Author

N68-17752# Joint Publications Research Service, Washington, D. C.

THE COMBINED EFFECT OF TWO-MONTH HYPOKINESIA AND RADIAL ACCELERATIONS ON THE CARDIOVASCULAR SYSTEM

G. P. Mikhaylovskiy, T. V. Benevolenskaya, T. A. Petrova, I. Ya. Yakovleva, O. I. Boykova, et al. *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 86–90 refs (See N68-17742 08-04)

Six healthy male test subjects were exposed to a 62 day bedrest and radial accelerations of the maximum tolerable magnitude. Bedrest reduced the strength of muscular vessels, disturbed ophthalmic and nasal regional circulation, and decreased orthostatic tolerance of all subjects. The latter was associated with some cardiovascular disorders and deterioration of circulatory adaptation mechanisms to a physical load. The combined effect of bedrest and radial accelerations on the cardiovascular system was more distinct than the single effects of acceleration. Physical exercises performed during bedrest yielded positive results. Author

N68-17753# Joint Publications Research Service, Washington, D. C.

FUNCTIONAL CHANGES IN THE NERVOUS SYSTEM AND FUNCTIONING AND CERTAIN ANALYZERS IN RESPONSE TO THE COMBINED EFFECT OF HYPOKINESIA AND RADIAL ACCELERATION

T. N. Krupina, A. Ya. Tizul, N. M. Boglevskaya, B. P. Baranova, E. I. Matsnev et al. *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 91–99 refs (See N68-17742 08-04)

The functional state of the nervous system and some analyzers was studied using six healthy male test subjects aged 23 to 36 years who had been subjected to a 62-day bedrest combined with radial accelerations. Three of the subjects performed physical exercises using a bunjee cord and bicycle ergometer. Prior to the bedrest experiment, the test subjects were twice (at an interval of 4 to 6 days) exposed to transverse accelerations. Transient neuro-autonomic disturbances were observed, the most distinct being autonomic and vascular disorders and asthenization phenomena which appeared earlier and disappeared later in test subjects performing no physical exercises. Functional changes of the acoustic and vestibular analyzers also were noted. These changes were related to an increase of the acoustic thresholds and decrease of the vestibulo-autonomic tolerance. The functional changes of the nervous system and some analyzers occur due to hemodynamic disturbances and afferent-efferent changes. Author

N68-17754# Joint Publications Research Service, Washington, D. C.

HUMAN BASAL METABOLISM DURING PROLONGED BEDREST

B. S. Katkovskiy. *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 100–107 refs (See N68-17742 08-04)

The metabolic rate and pulmonary function of healthy test subjects were studied during 20- and 62-day bedrest experiments, before and after which they were subjected to accelerations. Three subjects who performed no physical exercises during the 62 day bedrest revealed a decreased metabolic rate and virtually unaltered pulmonary function. Three test subjects who performed physical exercises during the experiments also manifested a reduction of oxygen consumption and metabolic rate beginning with the third 10 day period. It appears that the latter is unrelated to hypokinesia but is due to an increased physical conditioning or to adaptation to a changed hydrostatic pressure of body fluids. Author

N68-17755# Joint Publications Research Service, Washington, D. C.

RESULTS OF PHYSIOLOGICAL STUDIES PERFORMED IN A SLOW ROTATION CHAMBER

R. R. Galle and M. D. Yemel'yanov. *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 108–118 refs (See N68-17742 08-04)

Sixteen seven day experiments were carried out on test subjects in a slow rotation chamber which rotated at a rate of 10 and 40°/sec for study of the effect of centripetal and Coriolis accelerations on the human vestibular function. Individual peculiarities of the human body are of importance for its adaptation to this effect. The vestibular analyzer, especially its central parts, plays a significant role in the adaptation of the human body to prolonged rotation. Long term confinement inhibits the adaptation process. Results show that: (1) the angular rate of 40°/sec should not be regarded as the tolerance limit for man and (2) the prolonged rotation tolerance test can be used as an examination criterion. Author

N68-17756# Joint Publications Research Service, Washington, D. C.

ON THE INTERACTION OF ANALYZERS DURING WEIGHTLESSNESS

L. A. Kitayev-Smyk. *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 119–125 refs (See N68-17742 08-04)

Data on the effect of weightlessness on the analyzers are presented. Tests were performed on various animals and 270 humans during weightlessness created by jet parabolic flights. It is suggested that spatial perception results from the interaction of information provided by gravity receptors and optic analyzers. It is also indicated that emotional, psychic, vestibular–autonomic, and motor reactions are closely related in their functions. Author

N68-17757# Joint Publications Research Service, Washington, D. C.

CHARACTERISTICS OF REACTION OF THE HUMAN ACOUSTIC ANALYZER TO SOME SPACE FLIGHT FACTORS

Yu. V. Krylov. *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 126–133 refs (See N68-17742 08-04)

The dynamics of acoustic thresholds was studied on test subjects exposed to chronic noise, isolation, hypodynamics, an artificial atmosphere, and other factors characteristic of the space environment. Fluctuations of acoustic thresholds below 10 to 15 db can be classified as a reflection of the physiological rhythm and adaptation to a new environment. Fluctuations over 20 db can be interpreted as a manifestation of fatigue of the acoustic analyzer. A long term deprivation of acoustic signals results in a phenomenon of stable acoustic sensitization in man. The data indicate a significant adaptive capacity of the acoustic analyzer during human exposure to space flight factors. Author

N68-17758# Joint Publications Research Service, Washington, D. C.

BIOLOGICAL RHYTHMS AND DEVELOPMENT OF WORK AND REST REGIMES FOR COSMONAUTS

F. P. Kosmolinskaya. *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 136–141 (See N68-17742 08-04)

Biorhythmological research designed to determine tolerance levels and the degree of physiological (biorhythmic processes) adaptability of cosmonauts to solar time periods (i.e., the astronomical

day) is reported. Reviewed are papers presented at a symposium on "Biological Rhythms and the Formation of Work and Rest Regimes" which was held in Moscow during June 1967. Emphasized is the need to understand definite rhythmic variations so that optimum and specific work and rest regimes for cosmonauts can be developed. S.C.W.

N68-17759# Joint Publications Research Service, Washington, D. C.

ANNUAL MEETING OF THE ALL-UNION BOTANICAL SOCIETY

L. V. Dmitriyeva *In its* Space Biol. and Med., Vol. 1, No. 5, 1967 9 Feb. 1968 p 142–143 To be presented at the 39th Ann. Sci. Conf. of the Aerospace Med. Assoc., Bell Harbor, Fla., 6–9 May 1968 (See N68-17742 08-04)

Notes on the general annual meeting of the All Union Botanical Society which was held on April 3, 1967 are presented. Cited is the presentation of the reports on: (1) the basic theoretical premises for the development of closed life support systems using autotropic organisms as a regenerator of food, water, and the atmosphere; (2) experimental research for the development of a link of higher plants for such systems; (3) the principles for selecting agricultural plants for use in closed systems and (4) methods for cultivating plants under conditions of weightlessness. Problems of the quantity and quality of radiant energy in closed life support systems, and the closely associated problem of gas exchange of plants in such systems were also discussed. S.C.W.

N68-17780# Arizona Univ., Tucson. Dept. of Chemistry.

PHOTOBIOLOGY Final Report, 1 Oct. 1964–30 Sep. 1967

Gordon Tollin 10 Oct. 1967 68 p refs

(Contract AF 19(628)-4376)

(\FCRL-67-0590; AD-663752)

Molecular complexes of flavins with indoles and phenols were studied. Optical and thermodynamic properties provide insight into the role of charge transfer and other forces in these materials. The role of solvent was also investigated. The mechanism of phototaxis in Euglena was studied using a photoelectric technique. The response was shown to involve a shading from light of a photosensitive region by a carotenoid-containing organelle. The energy required to orient the organism with respect to the light source is derived from photosynthetic phosphorylation. Polarized light experiments indicate that the carotenoid molecules are aligned with their long axes parallel to the long axes of the organism. EPR and optical studies show reversible light-induced single electron transfer between chlorophyll and hydroquinone in solution. The role of oxygen and organic bases in this reaction has been elucidated. Quinones also participate in similar reactions. Studies using a variety of solvents have shown that solvent electrons are not involved in semiquinone radical formation and that carbonyl-containing solvents form complexes with the semiquinone radicals. Quenching experiments demonstrate that the chlorophyll triplet state is involved in both oxidation and reduction processes. Author (TAB)

N68-17790# Universidad Peruana de Ciencias Medicas y Biologicas, Lima (Peru).

THE ROLE OF ADRENAL CORTEX IN THE PROCESS OF ACCLIMATIZATION TO HIGH ALTITUDES Final Report

Federico Moncloa Rio de Janeiro (Brazil) Defence Res. Office Oct. 1967 15 p

(Contract DA-ARO-49-092-65-G89)

(Rept.-3; AD-663845)

Adrenal function and cortisol metabolism during acute exposure of sea level natives to 4,300 meters of altitude were studied. The results show the following: (a) Cortisol secretion rate is temporarily increased correlating with increases in its plasma concentration and in the urinary excretion of its metabolites; (b) Hypoxia does not result in a maximal stimulus for the adrenal cortex since it can be further stimulated by exogenous corticotrophin; (c) The adrenocortical response to high altitude can be blocked by the administration of dexamethasone; (d) The second compartment in which cortisol is distributed is diminished. This may be related with the contraction of the radiosulfate space, observed under the same experimental conditions; and (e) The metabolic clearance rate of cortisol is not significantly altered. Corticotrophin half-life (t 1/2) was also studied. Results indicate that a 24 aminoacids ACTH has a t 1/2 slightly longer than a 39 aminoacids ACTH. Using the same type of experiments the t 1/2 of the 39 aminoacids ACTH in 11 high altitude natives was also investigated. The results were similar to the ones obtained in the sea level controls.

Author (TAB)

N68-17862# FMC Corp., Santa Clara, Calif. Central Engineering Labs.

THE DEVELOPMENT OF BUILT-IN MECHANISMS FOR SOFTENING AND REHYDRATING COMPACTED FOOD BARS

R. A. Lampi Natick, Mass. Army Natick Labs. Dec. 1967 159 p refs *Its* Ser. FL-66

(Contract DA-19-129-AMC-44(N))

(TR-68-13-FL; AD-663827)

Compressed bars representing various vegetables and fruits, a cereal, a bakery item, meat, a casserole type item, non fat milk solids, and a high cook caramel candy were prepared in a manner to accentuate hardness. The effectiveness of various mechanisms for improving bitability and mastication were examined. A laminating technique resulting in a bar of thin layers held together with a mild binder was observed to be generally applicable, since individual layers could be separated for easy mastication and accelerated hydration. For fibrous products bitability was markedly improved by application of the compressive force at 90 degrees from the direction of the bite. Physical, chemical and sensory data are recorded for bars stored at four different temperatures. Author (TAB)

N68-18009*# National Aeronautics and Space Administration, Washington, D. C.

SENSATION PERIOD, A CONTRIBUTION TO THE THEORY OF TIME, SPACE, AND MOTION SENSATION [DIE EMPFINDUNGSZEIT, EIN BEITRAG ZUR LEHRE VON DER ZEIT-, RAUM- UND BEWEGUNGSEMPFINDUNG]

F. W. Froelich Dec. 1967 26 p refs Transl. into ENGLISH from Fischer Verlag (Jena), Pt. 2, 10. 1929 p 4–21, 234–245

(NASA-TT-F-11350) CFSTI: HC$3.00/MF$0.65 CSCL 06P

A historical review of the development of sensation time is followed by discussions of the correlation between sensation time and reaction time, based on psychological tests patterned on astronomic observations of star transits in various types of telescopes. Personal equation, systematic errors in reaction times, and response to various sensory stimuli are explained and discussed. Tabulated and composite results indicate that the reaction time depends on the intensity of the sensory stimulus and that reaction times to sound stimuli and electric skin stimuli are shorter than to light stimuli. Differing results of various authors are explained on the basis of personal equation, anticipatory reactions, and physical condition of the individual. A theory is developed for proving that stimuli of equal sensation time necessarily mean equally long reaction times. Author

N68-18023*# Scripta Technica, Inc., Washington, D. C.

OPINIONS CONCERNING FATIGUE AND MAN'S ADAPTATION TO HEAT [OPINIONS CONCERNANT LA FATIGUE ET L'ADAPTION DE L'HOMME A LA CHALEUR]

H. Laborit Washington NASA Feb. 1968 19 p refs Transl. into ENGLISH from Revue de Med. Navale (France), v. 14 1959 p 217–236

(Contract NASw-1694)

(NASA-TT-F-11476) CFSTI: HC$3.00/MF$0.65 CSCL 06S

Experiments aimed at maintaining or restoring normal metabolic functioning of cells in the case of work and fatigue in a hot environment. The following therapeutic suggestions are advanced: 1) An energy and dietetic supply of substances, which has not yet been studied sufficiently, but in which a major role can already be predicted for monosaccharides, vitamins, certain amino acids and ions; 2) The maintenance of a normal splanchnic vasomotor activity capable of preserving a correct hepatorenal functioning and limiting certain disturbances of the nitrogen metabolism; 3) A surveillance of the intestinal flora; 4) A guided replacement of hydro-electrolytic losses; 5) Control measures must rely on certain blood and urine examinations, but special attention should be given to the study of neuro-muscular excitability, in view of its simplicity and the wealth of information which it provides. Author

N68-18193*# National Aeronautics and Space Administration, Washington, D. C.
USE OF RADIOTELEMETRY IN SPACE MEDICINE [PRIMENENIYE RADIOTELEMETRII V KOSMICHESKOY MEDITSINE]
I. T. Akulinichev and R. M. Bayevskiy Feb. 1968 7 p Transl. into ENGLISH from Vestn. Akad. Med. Nauk SSSR, (Moscow), V. 2, 1964 p 60–66
(NASA-TT-F-11528) CFSTI: HC$3.00/MF$0.65 CSCL 06B

Discussion of systems transmitting biomedical data from manned spacecraft in orbit. The physiological measuring system in Vostok-3 and Vostok-4 capsules is described. The concerted effort between physicians, physiologists, physicists, mathematicians and chemists in the field of space medicine is stressed. No suggestions for the use of space medicine on the ground can be offered at this time, but a sharing of experience between terrestrial and space medicine must be continued. Author

N68-18248# Kansas State Univ., Manhattan. Dept. of Psychology.
THE VISUAL REALM IN SPACE. STUDY OF VISUAL PERCEPTION IN HUMANS AND ANIMALS
John Lott Brown Dec. 1967 37 p refs Paper presented at the Conf., Blacksburg, Va., 14–18 Aug. 1967
(Contract Nonr-3634(04))
(TR-4; AD-663575)

Mans presence on extended space missions is dictated by his unique effectiveness for coping with unusual situations. For his size, mass, and energy requirements, it is probable that he can handle a broader range of eventualities more effectively than any automatic equipment which might be designed. Critical elements in his performance are his sensory input channels. The most important of these is probably vision. Visual problems which may be encountered in space flight are reviewed. The unique characteristics of the visual realm on space missions are discussed, from the instrument arrays and other aspects of space vehicle interiors, to the extravehicular situations, from rendezvous and docking with other vehicles through landing on extraterrestrial bodies and exploration of their surfaces. The significant characteristics of the human visual system, which will be essentially the same is space as on the earths surface, are reviewed in relation to the problems which may be encountered. Author (TAB)

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N68-17341*# State Univ. of New York, Buffalo.
A GENERAL MODEL FOR MOTIVATIONAL ANALYSES OF EXCHANGE RELATIONSHIPS
Raymond G. Hunt [1967] 21 p
(Grant NGR-33-015-061)
(NASA-CR-93189) CFSTI: HC$3.00/MF$0.65 CSCL 05J

A conceptually simple, abstract model of motivational phenomena applicable across a wide variety of concrete events is developed. The rewards and incentives, motives and personality, and the exchange relations and power are discussed. The application is made to the buyer–seller, comsumer–supplier relations, and particular attention is given to the NASA–contractor dyad. N.E.N.

N68-17366*# Army Natick Labs., Mass.
POTENTIAL USE OF EXTRATERRESTRIAL RESOURCES IN LIFE SUPPORT SYSTEMS
Robert O. Matthern *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 187–189 refs (See N68-17350 08-30)

Extraterrestrial resources include those of geological origin, the atmosphere, solar and cosmic radiation, and possibly life. The uses of potential resources are discussed with respect to the functions of life support systems to provide food, water, atmosphere, optimum temperature, energy, and a means of waste disposal. Author

N68-17369*# Air Force Systems Command, Wright-Patterson AFB, Ohio.
SPACE CABIN TOXICOLOGY
Anthony A. Thomas *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 207–217 refs (See N68-17350 08-30)

Experiments to acquire toxicological information on various animals in an inhalation exposure facility are discussed. Details are given on the facility and the experiments exposing the animals to extended periods in cabin atmospheres, to pulmonary irritants and systemic poisons, and to volatile contaminants generated by cabin materials. It was determined that continuous exposure can lead to summation-of-interest type of toxic effect, that the atmospheric environment influences the outcome of toxic damage, and that cabin materials must be screened to insure crew health and performance. N.E.N.

N68-17380* National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
NONFLAMMABLE CLOTHING DEVELOPMENT PROGRAM
Matthew I. Radnofsky [1967] 37 p
(NASA-TM-X-60897) CFSTI: $3.00 CSCL 06Q

The flame resistant substitute materials program for manned spacecraft was undertaken to accomplish the following: (1) Find flameproof or nonflammable materials for spacecraft to eliminate combustibles from the crew-bay compartments. (2) Find a direct substitute for materials in the spacecraft which are fire-prone. (3) Improve the characteristics of the substitute materials by development and testing in actual use. (4) Establish a specification for material application based on all qualifying evaluations. The materials concerned are those which are primarily associated with the personal crew provisions of the astronauts, or the nonmetallic materials within the habitable areas of their spacecraft. The purpose of the program is to evaluate and develop the latest fibrous, plastic, and elastomeric materials for spacecraft cabin or space environment applications. The facilities used laboratory personnel are capable of testing and evaluating specific physical and functional performance characteristics of materials before, during, and after exposure to simulated-space and lunar-environment or spacecraft cabin conditions. Author

N68-17465# Air Force Systems Command, Wright-Patterson AFB, Ohio.
HANDLING QUALITIES AND PILOT WORKLOAD
C. B. Westbrook, R. O. Anderson, and P. E. Pietrzak *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 625–648 refs (See N68-17460 08-02)

This paper has the objective of defining the relationship between handling qualities and pilot stress and workload. The reasons underlying the importance of pilot work-load measurement are discussed and ways to analyze or treat pilot vehicle systems are reviewed. The various measures of pilot workload that have been used or considered are discussed and some new data on the possible use of pupil dilation as a measure of stress are presented. Author

N68-17467# Systems Technology, Inc., Hawthorne, Calif.
EFFECTS OF TASK VARIABLES ON PILOT MODELS FOR MANUALLY CONTROLLED VEHICLES
D. T. McRuer and H. R. Jex *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 659–701 refs (See N68-17460 08-02)

Some recent developments in analytical pilot models for manually controlled vehicles are summarized, with emphasis on the effects of task variables on the types of models required and on the model parameters. Validated analytical pilot models are shown to be available for a wide range of task variables. Different forms of pilot models, such as compensatory, pursuit, and periodic, are needed to handle the wide range of problems. The extra blocks in these models should not be overlooked in interpreting simulator and flight test data. A crossover model and refinements to the model are described which offer great simplifications in the modeling of compensatory tasks. With these simple models remarkably good estimates can be made of pilot equalization, gain, time delay, performance, and rating decrements. Multiloop tasks lead to models similar to those for single loop tasks, and most of the adaptation rules seem to be equally valid. An adaptive feedback selection hypothesis is presented which appears to be a powerful rule for selecting the most useful display quantities from an array of possibilities. A pilot's rating decrements can be related to his adopted model parameters to better optimize the pilot-vehicle system. R.N.A.

N68-17468# North American Aviation, Inc., Columbus, Ohio.
PILOT INDUCED INSTABILITY
Ralph C. A'Harrah and Raymond F. Sienert *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 703–722 refs (See N68-17460 08-02)

A simulator derived criteria for predicting pilot induced instability tendencies was successfully applied to 43 flight cases on 7 different aircraft. The criteria is considered suitable for general application, and, because of the fundamental parameters involved, is appropriate as a design guide in the preliminary design phase. Flight test application of the criteria should allow determination of the aircraft's pilot induced instability tendencies with a minimum of risk and a high confidence level. Author

N68-17472# North American Aviation, Inc., Los Angeles, Calif.
FACTORS AFFECTING PILOT LANDING TECHNIQUES
K. J. Dyda and N. M. Lefritz *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 813–830 refs (See N68-17460 08-02)

Simulator tests of supersonic transports were conducted to determine factors affecting pilot technique in approach and landing. Aircraft characteristics, instrument displays, and atmospheric environment were varied. Pilot knowledge of the conditions being evaluated was another variable. The simulator was validated against in-flight data prior to the tests. The data collected included pilot opinion rating, pilot/aircraft performance, and pilot workload measures. Results show that pilots concentrate on establishing a higher desired level of performance in controlling the vertical flight path in an approach and landing more than on the lateral path. Pilot ratings reflect the ability to obtain this desired degree of performance. Improving the pilot's performance capability in the lateral axis did not alter his workload or pilot opinion rating. A pilot's knowledge of the variables being studied and order of presentation can lead to erroneous pilot opinion rating, performance, and workload measures, as well as poor correlation among them. Pilot ratings consistently correlated with column workload for the landing task. R.N.A.

N68-17687# Human Factors Research, Inc., Santa Barbara, Calif.
GEOGRAPHIC ORIENTATION IN AIRCRAFT PILOTS: A SIMULATOR TEST OF A TEAM METHOD OF REPORTING TARGET LOCATIONS
James J. McGrath, William K. Earl, and William E. Osterhoff Oct. 1967 36 p refs
(Contract Nonr-4218(00))
(TR-751-12; AD-663549)

In low-altitude air reconnaissance, the pilot must acquire targets, describe and identify them, and report their locations. This experiment was conducted to determine whether the last job, reporting target locations, could be performed by someone other than the pilot. A simulator study was conducted in which the accuracy of target-location reports by single pilots was compared with the accuracy of reports made by plotters who were tracking the progress of the aircraft by means of voice reports from the pilot. The results showed that pilot/plotter teams could report target locations as accurately as single pilots. Pilots on the teams spent much less time looking at their charts than pilots working alone, however, the former had to spend a large portion of their time talking and listening to the plotter. It was concluded that plotters in voice communication with pilots could track an aircrafts progress and give real-time reports of target locations. The procedure gains head-up time for the pilot, but increases the pilots communication burden. Author (TAB)

N68-17636# Aerospace Medical Div. Aeromedical Research Lab. (6571st), Holloman AFB, N. Mex.
AN INEXPENSIVE HEAD RESTRAINT SYSTEM FOR LONG TERM INTRAVENOUS ADMINISTRATION OF DRUGS IN THE MONKEY
James G. Trost, William Talley, and Glayde D. Whitney Dec. 1967 13 p ref
(ARL-TR-67-27; AD-663447)

A head restraint system allowing intravenous administration and self-administration of compounds in monkeys under conditions of minimal restraint is described. The system has functioned well even with large male Macaques and requires no handling of the subjects for administration of drugs. Additional advantages of the present system, its ease of fabrication, light weight, and low cost are discussed. Author (TAB)

N68-17748# Joint Publications Research Service, Washington, D. C.
MATHEMATICAL MODELING OF HEAT AND HUMIDITY VARIATION IN AIRTIGHT SPACESHIP COMPARTMENTS
B. A. Adamovich, A. V. Kostetskiy, V. A. Kurochkin, and G. G. Ter-Minas'yan *In its* Space Biol. and Med., Vol. 1, No. 5 1967 9 Feb. 1968 p 30–39 refs (See N68-17742 08–04)

Differential equations of the fluctuation of temperature and relative humidity in spaceship compartments are presented. Using the model derived, temperature and humidity changes in the environmental control system and spaceship compartments are studied. The block diagram of the model for the computer program is given. Curves of the temperature and relative humidity fluctuations are plotted with respect to the assigned levels of the parameters in three connected compartments. Author

N68-17760# Washington State Univ., Pullman. Research Div.
THE SENSATION OF SOUND
Eugene W. Greenfield. *Its* Bull. No. 34 1967 32 p refs

A detailed explanation of the hearing process is presented. The discussion begins with descriptions of the ear's anatomy and performance characteristics followed by details of the outer, middle, and inner ear. The cochlea and the organ of Corti, their functions, and the conversion of mechanical energy into electrical pulses in these two organs are described. An experiment pointing to the analog to digital conversion-like process of the ear is discussed. Finally, consideration is given to the functions and structure of the auditory nerve and individual neurons, the concept of pulse coded hearing, and the auditory nerve pathways to the brain. R.N.A.

N68-17788# Naval Personnel Research Activity, San Diego, Calif.
SEQUIN 2: A COMPUTERIZED ITEM SELECTION AND REGRESSION ANALYSIS PROCEDURE
William J. Moonan, John G. Balaban, and M. Joyce Geyser Nov. 1967 52 p ref
(SRM-68-11; AD-663894)

A computer program called SEQUIN II is described. The procedure used in the program to select items from those available in a battery of tests has been characterized. The selections were made so as to develop scores for the tests which could in turn be used to predict a criterion score. The possibilities available for selecting items with other procedures or heuristics were presented. Applications of this technique to military and other testing programs were discussed and the computations for a particular application were illustrated. The use of the program in a computer system is described in detail and a listing of the FORTRAN statements is also given. Author (TAB)

N68-17792# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
AEROMEDICAL FACTORS IN AIR-REFUELED EXTENDED HELICOPTER FLIGHT Final Report
Charles R. O'Briant Nov. 1967 12 p refs
(AMRL-TR-67-47; AD-663727)

The development of a helicopter air refueling capability now greatly extends the time of nonstop flight possible. Helicopter crews may now be exposed to the possible adverse effects of prolonged periods of noise and vibration. A flight surgeon worked closely with the aircrews on the test program and flew as a crewmember on an 18-hour nonstop mission, which covered 2200 nautical miles and included several aerial refuelings. No notable adverse effects on or detectable physiological changes in the crewmembers occurred as a result of this extended 18-hour helicopter flight. Author (TAB)

N68-17839# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
DIGITAL COMPUTER SIMULATION OF VISUAL INFORMATION PROCESSING IN THE HUMAN BRAIN
William Clarke Hillsman (M.S. Thesis) Jun. 1967 152 p refs
(GA/EE/67-1; AD-663722)

A visual information processing system, based on selected aspects of human physiology, is simulated on the IBM 7094 digital computer through the use of over 50 test patterns. Monochromatic test patterns, represented by up to 2500 resolvable elements within a 50x50 array, are used to simulate static, foveal, monocular vision. Patterns are compared after scaling, rotation, and translation. The technique used for comparison which resembles the well known cross-correlation technique, is based upon the absolute-magnitude-of-the-difference of two functions; an algorithm is used for scaling and rotation. Similar and identical patterns are identified by means of empirically derived discrimination thresholds. Author (TAB)

N68-17876# Indiana Univ., Indianapolis. Hearing and Communication Lab.
SIGNAL DETECTION THEORY AND PSYCHOPHYSICS: A TOPICAL BIBLIOGRAPHY
James P. Egan Dec. 1967 166 p refs
(Contract Nonr-2300(05))
(AD-663906)

Approximately 1,000 references to current research in the area of signal detection theory and psychophysics are presented in series of categories. Author (TAB)

N68-17889# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE ABC OF OUTER-SPACE PILOTING [AZBUKA KOSMICHESKOGO PILITAZHA]
I. Merkulov 28 Jul. 1967 14 p Transl. into ENGLISH from Tekhn.-Molodezhi (USSR), no. 1, 1966 p 20–23
(FTD-HT-23-891-67; AD-663912)

Spacecraft guidance, control, stabilization, correction, deceleration, and landing systems are discussed. It is noted that the exhaust velocity of a spacecraft is 2000 - 4000 m/sec and that a parachute-landing engine system was employed in the soft landing of the Voskhod spacecraft. The engine was switched on when the spacecraft was close to the Earths surface so that it decelerated the drop of the parachute reducing the velocity to a negligible value at the moment of landing. TAB

N68-17925# Aerospace Corp., El Segundo, Calif.
MATERIALS FOR SPACE CABINS: THE FIRE HAZARD AND ATMOSPHERE CONTAMINANT CONTROL PROBLEMS
George Epstein and Edward F. Westlake, Jr. Oct. 1967 28 p refs
(Contract F04695-67-C-0158)
(TR-0158(3250-20)-8; SAMSO-TR-67-76; AD-663418)

The report discusses the flammability and atmospheric contaminant hazards associated with the use of plastics and other nonmetallic materials in manned spacecraft cabins. Outgassing characteristics and mechanisms of typical materials are described. Flammability and combustion rates are discussed as highly important materials selection factors. An approach is presented for minimizing the hazards through judicious selection and batch control of cabin materials. Author (TAB)

N68-18014*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ANALYSIS OF HUMAN RESPONSE IN COMBINED CONTROL TASKS
Hugh P. Bergeron, James J. Adams, and George J. Hurt, Jr. Washington Mar. 1968 55 p refs
(NASA-TN-D-4356) CFSTI: HC $3.00/MF $0.65 CSCL 05H

The simulation consisted of a primary control task to which were added secondary or side tasks. A trajectory control problem was used as the primary control task for the pilot. The trajectory task was a fixed-base simulation of a lunar letdown. The task-loading effects on the letdown were found to be predominant during the final hover and translation phase. All multitask tests were made by using either the lunar-letdown simulation or the multiloop representation as the primary control task. The secondary or side tasks consisted of: (1) a system-failures task integral to a typical space vehicle, and (2) a well-defined motor response task. The study generated a quantitative index of the information processing characteristics of a full (multitask) simulation. A method for determining the information processing requirements of a trajectory control task was devised to provide the quantity related to this index. By combining this quantity with the information processing measurements of the side tasks, the total workload for various combinations of tasks was determined. A quantitative analytical model was also generated for the multiloop control in a multitask simulation. A duty-cycle shaping technique developed in this study was used to generate the model. Author

N68-18072# General American Transportation Corp., Niles, Ill. General American Research Div.

A CLOSED SYSTEM RESPIRATORY EVALUATOR Final Report, 1 Jul. 1965–31 Jul. 1966

Max Sussman Wright-Patterson AFB, Ohio AMRL Oct. 1967 68 p refs

(Contract AF 33(615)-2830)

(MR-1285; AMRL-TR-66-246; AD-663754) CSCL 06B

The CSRE simulates human respiration and performs all the metering, sensing, and recording functions necessary to evaluate the performance of space cabin simulators, pressure suit systems coupled to their environmental control systems; environmental control systems; life support systems; and rescue and survival systems. The respiratory functions simulated include oxygen consumption and carbon dioxide, water vapor and heat production. Oxygen consumption is simulated by physically extracting from the system under test gas at a rate sufficient to equal the oxygen consumption rate. Carbon dioxide production is simulated by bleeding CO2 into the system from a storage bottle. Water vapor is introduced by a conventional type humidifier while heat is added by an electrical radiator. The gas rates and heat are computed and automatically controlled by an analog computer directed electromechanical control system. The system thereby avoids the delicate problems of control, balance, undesirable by products, and erratic performance found in systems utilizing adsorption-absorption techniques, catalytic oxidation, or organic materials oxidized to provide the correct carbon dioxide, water, and heat input with simultaneous oxygen removal. Author (TAB)

N68-18080*# Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.

STATE SPACE MODELS OF REMOTE MANIPULATION TASKS

Daniel E. Whitney (Ph.D. Thesis) Jan. 1968 192 p refs

(Grant NsG-107-61)

(NASA-CR-93360; DSR-70283-5) CFSTI: HC $3.00/MF $0.65 CSCL 05H

This thesis presents a formal structure by which a computer may aid the operator and the manipulator. The computer maintains a model of the task site, controls the manipulator, and receives commands from the operator. The model is a discrete representation of all the consequences of executing atomic commands selected from a limited set. The consequences of any command or string of commands is a new configuration of objects; each configuration, differing from its most similar neighbors by what one atomic command can accomplish, is called a *state* of the task site. Hence, the model is a *state space* representation of the task possibilities theoretically attainable using strings of these commands. Upon receiving the operator's command, the computer must find a sequence of atomic commands which, in principle, will carry the task site from the current state to the desired state. Each command is assigned a cost, which may depend on fuel or time consumed, risk or uncertainty, or arbitrary units. A search algorithm finds that path between initial and final states which costs the least. Author

N68-18132 Royal Aircraft Establishment, Farnborough (England).

THE ROLE OF THE PILOT IN ALL-WEATHER OPERATION

J. C. Morrall Jun. 1966 34 p refs

(RAE-TM-BLEU-123)

The total tasks a pilot must perform during an instrument approach and landing are summarized, cockpit procedures are outlined, and the instruments which provide the necessary information are described and their performance plotted. On the basis of the above, design criteria are recommended for a head-up display which would allow for easy and progressive transition from instrument to visual flight and for rapid reversal to instrument information if needed. In all-weather operating conditions, the pilot would have all vital information in one place, allowing him to piece together instrument information, visual information if available, and information on subsystem failures. Such a design would provide for pilot interpretation of the situation and decision making in place of the simple go, no-go choice currently available. A pereferred panel layout and suggested failure warning indicators are depicted. E.J.S.

N68-18142*# Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn.

RESEARCH AND DEVELOPMENT PROGRAM FOR A COMBINED CARBON DIOXIDE REMOVAL AND REDUCTION SYSTEM, PHASE 2A Final Report, Sep. 1966–Nov. 1967

Nov. 1967 373 p refs

(Contract NAS1-4154)

(NASA-CR-66519; HSER-4908) CFSTI: HC $3.00/MF $0.65 CSCL 06K

This work is concerned with electrochemical processes for the removal and reduction of carbon dioxide through the electrolysis of a fused salt and with engineering activities to select a practical electrolytic cell configuration. Research was conducted on the three basic functions of the fused carbonate CO_2 reduction cell: the oxygen-producing anode, the carbon-collecting cathode, and the CO_2-absorbing scrubber. Analyzed were composition and properties of the electrolyte, processes at the electrode and their control, and the susceptibility of materials to chemical attack by liquid and gaseous reactants. Several cathode configurations were demonstrated, and conditions were established for controlling high quality carbon deposition at higher current densities than seemed feasible at first. The anode was shown to be primarily a materials and configuration problem. Scrubbing of carbon dioxide was demonstrated in practical configurations. A laboratory demonstration model was fabricated for independent CO_2 removal-reduction experiments and for testing alternative concepts. Cell performance and corrosion were tested. An oscillating electrolyte concept was selected for a four-man cell complex design. Cathode efficiency and carbon purity values of approximately 100% and 75 to 85%, respectively, were attained. Specifications for a zero-gravity CO_2 removal and reduction system were prepared. K.W.

N68-18187*# General Electric Co., Philadelphia, Pa. Missile and Space Div.

VARIABLE FLEXIBILITY TETHER

David J. Withey Feb. 1968 36 p refs

(Contract NAS9-7336)

(NASA-CR-65966) CFSTI: HC $3.00/MF $0.65 CSCL 06B

A prototype restraint and positioning system for use by an astronaut during EVA has been designed, fabricated, and assembled. The system utilizes two variable flexibility tethers, one mounted on each hip, to form a double hip tether restraint system. The unique feature of the system is that the tethers may be selectively rigidized to varying degrees in any random curvature or shape as required by the astronaut. The tether is constructed of many ball and socket links, strung over a central cable. To rigidize the tether, the astronaut cranks the handle of a hip mounted controller which applies tension to the cable, and a compressive load to the ball/socket joints. The resulting friction between the balls and sockets maintains the tether rigidity, the degree of rigidity being a direct function of cable tension. To relax the tether, a quick release mechanism is incorporated into the control handle. The distal ends of the tethers consist of modified "vise grip" pliers suitable for attachment to a variety of work stations. Author

N68-18218# Institute for Perception RVO-TNO, Soesterberg (Netherlands).

TIMING IN TEMPORAL TRACKING

J. A. Michon 1967 130 p refs

(TDCK-49194; IZF-1967-18)

A framework is developed for describing the temporal relations between the elements in a chain of actions, and a formal model

of timing is provided to account for sequential dependence that may be present in certain conditions. The approach adopted is related to the systems analysis models of spatial (manual) tracking, since serial production of intervals (key tapping) may be considered as the temporal analog of spatial tracking performance. In the basic experiments, subjects tried to synchronize taps on a key with a series of clicks presented to them through earphones. Data were obtained on the type of dynamic mechanism responsible for timing in key tapping, for the case of stationary and modulated inputs respectively, and were used to derive some formal properties of a time sense conceived of as a dynamic system. The influence of information process load on the timing mechanism is considered, and three experiments are presented on the impact of a well defined component of information processing load, event uncertainty, and timing behavior. Various aspects of the timing system are summarized and stated in the form of an information processing model. M.G.J.

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N68-17227# Dordt Coll., Sioux Center, Iowa.
[ON GELS]
Russell Maatman 1 Nov. 1967 5 p refs
(Contract AT(11-1)-1354)
(COO-1354-13)

Developments are reported for studies on: reactions of aqueous salts with chromia-alumina; behavior of aqueous solutions of salts in the pores of high-surface-area carbon; reactions between aqueous Ni^{2+} and high-surface-area alumina and the nickel-alumina catalyst; reactions between aqueous platinum and high surface-area alumina and the platinum-alumina catalyst; and reactions of inert-gas-type ions with alumina, and the relation between this reaction and the catalytic properties of alumina. N5A

N68-17237# Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics.
A STUDY OF THE CRYSTALLIZATION OF THE DISODIUM, DIBARIUM, AND MAGNESIUM SALTS OF ADENOSINE TRIPHOSPHATE
Jane Barbara Lian (M.S. Thesis) 30 Nov. 1967 50 p refs
(Contract W-7401-ENG-49)
(CUR-49-866) CFSTI: HC$3.00/MF$0.65

The disodium salt of adenosine triphosphate (ATP) was crystallized from aqueous solutions under various conditions by addition of either ethanol, isopropanol, n-propanol, tert-butyl alcohol, ethylene or propylene glycol, dimethysulfoxide (DMSO), and tetrahydrofuran (THF) or acetonitrile. The crystallization of Na_2H_2ATP was undertaken to obtain crystals suitable for X-ray diffraction. It was also hoped that a general procedure for crystallizing tripolyphosphates could be developed. The attempted crystallization of the magnesium salt of ATP is also described. Since the Mg-ATP was prepared from the dibarium salt of ATP, the Ba_2ATP-solvent system was also studied. Barium and magnesium ATP complexes could not be crystallized either following the procedure used for the crystallization of the sodium ATP or by the other techniques tried. The effects of the solvents and conditions of temperature, pH, and concentration on the crystallization and the stability of the Na_2H_2ATP crystals are discussed. Author (NSA)

N68-17262# Iowa State Univ. of Science and Technology, Ames.
DEPENDENCE OF THE THULIUM AND NEODYMIUM 2-HYDROXYISOBUTYRATES STEP-FORMATION CONSTANTS ON IONIC STRENGTH
Maureen Welling Matkovich (M.S. Thesis) Nov. 1967 56 p refs
(Contract W-7405-ENG-82)
(IS-T-208) CFSTI: HC$3.00/MF$0.65

The stoichiometric step-formation constants of the neodymium and thulium 2-hydroxyisobutyrate (2-methyllactate) complexes were determined at 25°C and at ionic strengths from 0.05 to 0.70, by a potentiometric method. The ionic strength was adjusted with KNO_3. The ratio of the first and second step-formation constants was determined at each ionic strength. The ratio was found to decrease exponentially with the increasing square root of ionic strength. The thermodynamic ratio of the first and second constants was extrapolated by a least squares technique. From the thermodynamic ratio and with the use of a coulombic factor, it is proposed that the 2-hydroxyisobutyrate anion bonds tridentately to the larger rare earth cations and bidentately to the smaller rare earth cations. Author (NSA)

N68-17272# Los Alamos Scientific Lab., N. Mex.
DETERMINATION OF OXYGEN IN GERMANIUM BY ^3He ACTIVATION
D. Holm, W. Briscoe, J. Parker, and Wm. Mort Sanders [1967] 10 p refs Presented at the 14th Nucl. Sci. Symp., Los Angeles
(Contract W-7405-ENG-36)
(LA-DC-8866; CONF-671026-10) CFSTI: HC$3.00/MF$0.65

The reactions $^{16}O(^3He, p)^{18}F$ and $^{12}C(^3He, ^4He)^{11}C$ enable measurements of very small amounts of oxygen and carbon in a matrix of high atomic number. The products are positron emitters with convenient half lives of 110 and 20.4 min, respectively. Germanium samples of various qualities were analyzed for oxygen and carbon using this technique in an attempt to establish a correlation between the level of these contaminants and the performance of the material in detector applications. The contaminant levels observed were about 10 ppM and little or no correlation was observed. Author (NSA)

N68-17294# Ludwig-Maximilians-Universitat, Munich (West Germany).
THEORETICAL APPROACH TO THE PROBLEM OF CLUSTER ION FORMATION [BERECHNUNGSMOEGLICHKEITEN FUER DIE BILDUNG VON CLUSTER-IONEN]
Chr. Hohla and V. Mohnen Aug. 1967 49 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-74)

Usually the mass of an ion is not the same as it was immediately after the ionization process. Cluster ions are formed by the attachment of neutral atoms or molecules. The number of attached atoms or molecules was calculated on the basis of an equilibrium condition. In order to demonstrate this method the relatively simple system of lithium ions in krypton was used. For the calculation of the partition function one has to know the potential distribution as well as the ionic radius. By the proposed method one can estimate or calculate the number of attached atoms or molecules as functions of pressure and temperature and for each system of constituents. Author (NSA)

N68-17325# Argonne National Lab., Ill. Chemical Engineering Div.
KINETICS OF THE TITANIUM-NITROGEN REACTION WITH APPLICATION TO THE DESIGN OF GETTERING SYSTEMS
M. L. Kyle, L. F. Coleman, R. D. Pierce, and J. D. Arntzen Apr. 1967 34 p refs
(Contract W-31-109-ENG-38)
(ANL-7167) CFSTI: HC$3.00/MF$0.65

The rate of reaction between titanium-metal sponge and nitrogen in argon–nitrogen mixtures was studied at 900°C. The reaction rate depends upon the partial pressure of nitrogen in the gas phase. At least three titanium-nitrogen solid phases are formed as the reaction proceeds, and the rate-controlling mechanism is

believed to be the diffusion rate of atomic nitrogen through the $TiN_x(\delta)$ phase. A single relation has been developed which satisfactorily describes the reaction kinetics at nitrogen partial pressures. Additional mathematical relationships have been developed to permit the design of titanium gettering systems for the removal of nitrogen from argon. These relationships apply to the following operating conditions: nitrogen concentrations in argon from 50 to 50,000 ppM; a reacting temperature of 900°C; total pressure near 1 atm; titanium–metal sponge of a surface area near 800 cm^2/g; and low (≈1 ppM) oxygen and water content of the gas. Under these conditions, the relations presented should permit the design of a gettering system with an uncertainty of about ±10% in the required bed size and useful life. Author (NSA)

N68-17328# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.

PERMEATION, DIFFUSION, AND SOLUTION OF NITROGEN IN TUNGSTEN AND MOLYBDENUM

R. Frauenfelder 30 Jun. 1967 38 p refs

(Contract AT(30-1)-2823)

(WERL-2823-28) CFSTI: HC $3.00/MF $0.65

Using ultrahigh vacuum- and mass spectroscopic techniques, permeation, diffusion, and solution of nitrogen in tungsten and molybdenum were measured for pressures between 5×10^{-5} and 500 Torr and for temperatures between 1100 and 2500°K. Values for the permeation constants, diffusion constants, and solubility constants, are given. For nitrogen in molybdenum, the value found for the frequency factor of the diffusion constant is in agreement with Zener's theory of interstitial atomic diffusion. For nitrogen in tungsten, the values found for both the frequency factor of the diffusion constant and the diffusion activation energy are abnormally high and not in agreement with Zener's theory. The results obtained for the solubility constants are critically compared with previously published data. Author

N68-17335# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.

PERMEATION OF HYDROGEN THROUGH TUNGSTEN AND MOLYBDENUM

R. Frauenfelder 23 Jun. 1967 58 p refs

(Contract AT(30-1)-2823)

(WERL-2823-27) CFSTI: HC $3.00/MF $0.65

Using ultrahigh vacuum- and mass-spectroscopic techniques, permeation of hydrogen through wrought- and vapor-deposited tungsten tubes and through a drawn molybdenum tube was measured for pressures between 10^{-6} and 200 Torr and temperatures between 1050 and 2400°K. The permeation rates varied with pressure and temperature in a complex manner. Analytical expressions for the permeation rate are derived which are based on the assumptions that a) the rate determining step of the permeation process is diffusion of hydrogen in the bulk of the sample and b) the rate of desorption of hydrogen atoms, the rate of recombinative desorption of hydrogen molecules, and the concentration of dissolved hydrogen atoms are each determined by the concentration of hydrogen atoms adsorbed on the surface of the permeation sample. Author

N68-17340 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

STUDIES ON THE HIGH TEMPERATURE SYNTHESIS OF AMINO ACIDS AND THEIR PRECURSORS. 1: THE EFFECTS OF VARIATIONS IN THE SUBSTRATES CONTENT IN A THREE-COMPONENT SYSTEM CH_4–NH_3–H_2O [STUDIA NAD WYSOKOTEMPERATUROWA SYNTEZA AMINOKWASOWI ICH PREKURSOROW 1. WPLYW ZMIAN ZAWARTOSCI SUBSTRATOW W UKLADZIE TROJSKLADNIKOWYM: CH_4–NH_3–H_2O]

Mieczyslaw Taube, Krystyna Samochocka, Stanislaw Z. Zdrojewski, and Krystyna Jezierska Nov. 1967 56 p refs

(Contract IAEA-562/RB)

(INR-838/C)

The aim of the present report has been to determine the conditions of high-temperature synthesis allowing the maximum yields of amino acids and their precursors as related to the dosage velocity of substrates, changes of substrates, variations in the reaction time of substrates in high-temperature zone and changes of contact substances. 12 amino acids with the total yield of 0.1–0.2 %/g NH_3 as well as 46 intermediates have been obtained. It seems that the Strecker reaction is not in the experimental conditions the main mechanism of amino acids formation. Author

N68-17382*# Battelle Memorial Inst., Columbus, Ohio.

DEVELOPMENT OF CHEMICAL ANALYSIS TECHNIQUES FOR ADVANCED MATERIALS Annual Summary Report, 17 Jan. 1967–16 Jan. 1968

E. R. Blosser 2 Feb. 1968 48 p ref Prepared for JPL

(Contracts NAS7-100; JPL-951578)

(NASA-CR-93183) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Studies include: (1) determining the hydroxyl content of MgO by mass spectrographic and chemical decomposition techniques investigating the effect of several means of causing the decomposition, (2) standardizing the mass spectrograph by suitable cross-check data, (3) studying the effects of storage time, degree of subdivision, and heating on the carbon value as determined by combustion, (4) optimizing the sample preparation for mass spectrographic use, and (5) increasing the accuracy of the mass spectrograhic technique by several means. Significant progress has been made in all these areas, but the hydroxyl and carbon determinations remain the most troublesome. Author

N68-17386# National Research Council of Canada, Ottawa (Ontario).

ELECTROCHEMICAL MEASUREMENT OF OXYGEN DIFFUSION IN METALS AT HIGH TEMPERATURES [ELEKTROCHEMISCHE MESSUNG DER SAUERSTOFFDIFFUSION IN METALLEN BEI HOHEREN TEMPERATUREN]

Hans Rickert and Rolf Steiner 1967 13 p refs Transl. into ENGLISH from Z. Phys. Chem. (Frankfurt) Neue Folge, v. 49, no. 3–4, 1966 p 127–137

(NRC-TT-1295) CFSTI: HC $3.00/MF $0.65

An electrochemical method is described by which it is possible to measure oxygen diffusion in solid and liquid metals at high temperatures, using doped zirconium dioxide as a practically pure ion conductor for oxygen ions. A diffusion flow of oxygen is converted into an electric current. Potentiostatic measurement was found to be especially advantageous. Measurement in linear and cylindrical geometry is fully discussed. As a model, the oxygen diffusion coefficient is measured in solid silver between 760 and 900°C. The electrochemically measured diffusion coefficient agrees well with the value obtained by other methods. Author (NSA)

N68-17395# Technische Hogeschool, Eindhoven (Netherlands).

DISPLACEMENT ELECTROPHORESIS IN NARROW HOLE TUBES

Frans Matheus Everaerts (Ph.D. Thesis) [1967] 133 p refs

Displacement electrophoresis and related phenomena and calculations are discussed, and the technique is compared to other analytical separation techniques. The drop in concentration of successive zones as the mobility of the ions decreases is described. The pH changes the use of a buffer counter ion are considered, and formulas are given for pH calculations. Temperature profiles along the tube length are calculated, and the construction of thermocouples of low heat capacity is outlined. Electro-kinetic phenomena and electro-endosmotic flow are described, along with polymers used to prevent the phenomena. False signals from gas

bubble formation in the tube are mentioned. The relations between the quantity of the ion species introduced in the sample-tap and the distance between the peaks in the electropherogram are given for the cases when arrowroot and when hydroxyethylcellulose are used. The possibility of separating weak acids when a buffer ion is used is also described. N.E.N.

N68-17405# Los Alamos Scientific Lab., N. Mex.
SOME RECENT DEVELOPMENTS IN THE THEORY OF PHASE TRANSITIONS
Leonard W. Gruenberg (MIT) 7 Dec. 1967 10 p refs
(Contract W-7405-ENG-36)
(LA-3805-MS) CFSTI: HC $3.00/MF $0.65

A discussion of the Landau theory of second-order phase transitions, generalized to take into account fluctuations, the breakdown of superfluidity in one and two dimensions, and the scaling laws is given. Author

N68-17410# Defence Standards Labs., Maribyrnong (Australia)
DETERMINATION OF WATER SOLUBLE ADDITIVES IN LIQUID HYDROCARBON FUELS
E. C. Kuster and D. Comery Sep. 1967 9 p
(DSL-TN-103)

Based on refractive index measurement of an aqueous extract, a simple, accurate method for determining water soluble additives in fuel is described. The method is accurate to 0.004% in the concentration range from 0 to 0.20% volume, uses simple and easily transportable equipment, and is equally convenient for field or laboratory determinations. Author

N68-17427*# Brigham Young Univ., Provo, Utah. Dept. of Chemistry.
STUDIES OF REACTION GEOMETRY IN OXIDATION AND REDUCTION OF THE ALKALINE SILVER ELECTRODE Quarterly Report
E. A. Butler and A. U. Blackham 15 Feb. 1968 15 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951911)
(NASA-CR-93197; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 07C

A reproducible roughness factor of 1.74 has been found for silver foil which has been oxidized in the ammoniacal electrolyte. This roughness factor will be used as a correction for all current density and overpotential data. Preliminary investigation of alternative methods for the determination of the effective electrolytic surface area of sintered and foil silver electrodes have been performed. The basis for these determinations of the surface area is an oxidation of the silver electrode at a constant potential. The development of the necessary instrumentation for further study is now under way. Silver foil was oxidized with and without ultrasonic vibrations at various current densities with the temperature controlled to ±0.1°C. The increase in charging capacity was larger at high and low current densities than at moderate current densities. Vibration prior to oxidation failed to increase charging capacity, indicating that no persisting strains in the silver occur and that surface cleaning by the ultrasonic vibrator plays no significant role. Author

N68-17488# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Raketentreibstoffe. Abt. Spektroskopie.
A NEW $C^1\Pi_g$-$b^1\Pi_u$ BAND SYSTEM OF THE C_2 MOLECULE AND THE DISSOCIATION OF THE $c^1\Pi_g$ STATE BY ROTATION [EIN NEUES $C^1\Pi$-$b^1\Pi_u$-BANDENSYSTEM DES C2-MOLEKUELS UND DIE DISSOZIATION DES $C^1\Pi_g$-TERMS DURCH ROTATION]
C. Messerle Dec. 1967 33 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-83) CFSTI: HC $3.00/MF $0.65

Homogeneous rotational perturbations ($\Delta\Lambda=0$) were found in the Deslandres-d'Azambuja bands ($c^1\Pi_g$-$b^1\Pi_u$) for $v' \geq 3$. The rotational analysis showed that the $c^1\Pi_g$ state is perturbed by a hitherto unknown $c'^1\Pi_g$ state. Vibrational levels and rotational constants of the $c'^1\Pi_g$ state were determined from $v=0$ up to $v=5$. Furthermore some additional vibrational levels of the $c^1\Pi_g$ state could be identified up to $v=8$. The detection of the $c'^1\Pi_g$ state explains the observed strong vibrational perturbation of the $c^1\Pi_g$ state. The mutual position of the two $^1\Pi_g$ potential curves is plotted approximately. The C_2 spectrum was excited in a low pressure arc. In this arc the rotational structure of the C_2 bands could be followed up to very high rotational quantum numbers. In the $c^1\Pi_g$ state a dissociation by rotation was observed. This effect yields $D_d(C_2) = (6.11 \pm 0.04)$ eV. Additionally the dissociation products of the Π_g states could be fixed unambiguously. Author

N68-17541*# California Univ., Berkeley.
THE ISOLATION AND STRUCTURAL ELUCIDATION OF VOACRISTINE HYDROXYINDOLENINE
H. K. Schnoes, David W. Thomas, R. Aksornvitaya, William R. Schleigh, and S. Morris Kupchan Aug. 1967 9 p refs Prepared jointly with MIT
(Grants NSG-101; NIH GM-10523; NIH GM-09352; PHS-HE-02952)
(NASA-CR-93156) CFSTI: HC $3.00/MF $0.65 CSCL 07C

Details of the extraction and preliminary fractionation of voacristine hydroxindolenine and its characterization and synthesis from voacristine are presented along with the experimental methods and instrumentation used. R.N.A.

N68-17562# Bureau of Mines, Amarillo, Tex. Div. of Engineering.
COMPUTING VOLUME OF HELIUM IN CYLINDRICAL STEEL CONTAINERS AT 10 TO 10,000 psia
Herbert S. Kalman Mar. 1968 216 p refs Revised
(BM-IC-8367)

A table of factors for rapid, accurate calculation of the volume of pure helium in cylindrical steel containers, at base conditions of 14.7 psia and 70° F, is presented. The table covers a pressure range from 10 to 10,000 psia in 10-psi increments and temperature range of 0° to 120° F in 2° increments. The volume of helium is calculated from the observed pressure and temperature of the helium, expressed as a factor from the table, and the known internal volume of the container. The calculation requires a single multiplication. A discussion and evaluation of the accuracy obtainable and a derivation of the formula used (which takes into account compressibility of helium, thermal expansion of steel containers, and the stretch of steel due to internal pressure) are presented. An example showing how the table can be used is given also. Author

N68-17608# Kaman Aircraft Corp., Colorado Springs, Colo.
DEVELOPMENT OF FAST NEUTRON ACTIVATION ANALYSIS FOR LIQUID LOOP SYSTEMS
D. E. Wood Jul. 1967 31 p refs
(Contract AT(29-2)-2115)
(KN-67-458(R); TID-24029) CFSTI: HC $3.00/MF $0.65

A liquid loop activation analysis system has been constructed and tested for use in developing on-line analytical capabilities for future industrial installations. The system can simulate process streams with variable flow rates and times of decay and counting. Several counting channels are provided with variable windows to allow selection of various gamma rays for analysis. Applications to several industrial problems have been tested and shown promising for continued work and possible system installation. Author

N68-17663# Institut d'Aeronomie Spatiale de Belgique, Brussels.
STUDY OF THE $NO+O_3$ REACTION IN CROSSED MOLECULAR BEAMS [ETUDE DE LA REACTION LUMINEUSE $NO+O_3$ DANS DER RAYONS MOLECULAIRES]

M. Ackerman 1967 17 p refs In FRENCH; ENGLISH summary Presented at the Acad. Roy. des Sci., Brussels, 2 Dec. 1967 *Its* Serial A-N055-1967 Submitted for publication
CFSTI: HC $3.00/MF $0.65

The $NO+O_3 \rightarrow NO+O_2$ reaction has been studied in crossed molecular beams. The glow produced by the radiative decay of the excited NO_2 formed at the beams intersection has been photographed at various wavelengths. The reaction rate constant has been evaluated, some informations have been obtained on the energetic of the process and on the radiative lifetime of NO_2. Author (ESRO)

N68-17732*# Pennsylvania Univ., Philadelphia. Electrochemistry Lab.
STUDIES IN FUNDAMENTAL CHEMISTRY OF FUEL CELL REACTIONS APPENDIX A Semiannual Progress Report, Jul. 1–Dec. 31, 1967
John O' M. Bockris 31 Dec 1967 83 p refs
(Grant NsG-325)
(NASA-CR-93263; SAPR-11, App. A) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Consideration is given to the electrocrystallization of deposited zinc in a dendritic form in the operation of silver–zinc and zinc–air batteries. Details are presented on the electrolytes and electrodes used in the cell designed to allow direct observation of the zinc deposition process and visual method for the determination of dendrite growth rates. The results are discussed in relation to the qualitative observations of the dendrite initiation time ,and morphology of deposited zinc, change in the total current with respect to time, rate of dendrite propagation, and influence of dendrite propagation current upon the measured total current. Equations are given to calculate diffusion controlled deposition onto rough surfaces, time dependence of the current density during the diposition, and ratio of dendrite propagation. It is concluded that this model for dendritic growth, based on electrodic parameters, can be applied to all metals. The most important electrodic parameter is the exchange current density of the metal deposition process. B.S.D.

N68-17761# Coating and Chemical Lab., Aberdeen Proving Ground, Md.
PETROLEUM OIL CHARACTERIZATION USING CARBON TYPE ANALYSIS AND INFRARED SPECTROSCOPY Final Report
M. E. Lepera Dec. 1967 35 p refs
(CCL-243; AD-663816)

The composition of petroleum oil was investigated using carbon type analysis and infrared spectroscopy. Samples of lubricant basestocks from different crude sources, finished engine lubricants, and commercial process oils were obtained for evaluation. Both methods of analysis provided a means to characterize or define hydrocarbon types present in the petroleum oil samples. An absorbance ratio of aromaticity-paraffinicity was subsequently developed to permit a rapid assignment of the relative hydrocarbon composition of petroleum oil samples. Author (TAB)

N68-17782# Naval Research Lab., Washington, D. C.
PREPARATION AND WETTABILITY OF TERMINALLY CHLOROPHENYL-SUBSTITUTED CARBOXYLIC ACID FILMS Interim Report
Elaine G. Shafrin and W. A. Zisman 26 Oct. 1967 21 p refs
(NRL-6621; AD-663553)

Surface-active compounds can be designed to adsorb on solid surfaces to increase the adhesion of liquids, protective coatings, and resins. Often it is feasible to fulfill these requirements without necessitating a chemical reaction with both the adherend and adhesive. Various terminally substituted chlorophenylalkyl mono- and polycarboxylic acids were designed as potential adhesion promoters for certain classes of adherends. Methods were evolved for preparing an adsorbed monolayer of each compound by the melt retraction and other techniques. The wettability properties and the high critical surface tension obtained were consistent with values to be expected for such chlorine-rich surfaces. Moreover, the wettability proved insensitive to changes in homology and structure in these promoter molecules. Similarly, no changes in wettability were observed when the metal adherend was changed. The future implications of these results for improving the adhesion of protective coatings and adhesives were considered. Author (TAB)

N68-17823 Pennsylvania Univ., Philadelphia. Electrochemistry Lab.
ELECTROCHEMICAL CATALYSIS
J. O'M. Bockris and H. Wroblowa *In* AGARD Combust. and Propulsion 1967 p 717–767 refs (See N68-17793 08-03)

The factors affecting the rates of chemical and electrochemical reactions are discussed. The differences between chemical and electrochemical catalysis arising from the existence of the applied field and from the presence of solvent are shown from the theoretical and experimental points of view. A review of the possible ways to enhance electrocatalysis is presented. The mechanisms of several electrode reactions (oxidation of hydrogen, hydro-carbons, oxalic acid, oxygen reduction) pertinent to fuel cell reactions are discussed in detail, as a prerequisite to all catalytic considerations. A crude attempt is made to formulate some theory of the mechanism of catalysis, on the basis of an experimental comparison of the reaction rates on various catalysts of hydrogen and oxygen evolution and of ethylene oxidation. Needed trends in research are indicated. Author

N68-17838# Foote Mineral Co., Exton, Pa. Research and Engineering Center.
CONFIGURATION INVESTIGATION FOR LITHIUM OXIDE CARBON DIOXIDE CONTROL SYSTEMS Final Report, Dec. 1965–Dec. 1966
Daniel A. Boryta and Eugene W. Dezmelyk Wright-Patterson AFB, Ohio AMRL Oct. 1967 159 p refs
(Contract AF 33(615)-3382)
(FOOTE-1266; AMRL-TR-67-62; AD-663762)

The bulk density of lithium oxide shapes and granules has been increased substantially while retaining good reactivity. Absorbent forms of the oxide can be prepared in the bulk density range of 0.18 to 0.28 g/cc. For granular oxide, results indicate a reasonable compromise between reactivity and absorbent volume efficiency is about 0.20 g/cc in passive systems and 0.26 to 0.28 g/cc in semipassive or dynamic systems. The improvement results from use of high (about 18 m sq/g) surface area lithium peroxide raw material and techniques in processing the peroxide to oxide. Tests indicate the oxide forms developed can equal (passive exposure) or exceed (semipassive or dynamic exposure) the 0.8 g CO_2/g LiOH capacity of granular lithium hydroxide before 2% breakthrough. Dusting of the granular oxide form was reduced by controlled abrasion and fabric encasement techniques. Tests at one-third and normal atmospheres indicated higher carbon dioxide absorption rates at the lower pressure. A marked improvement was found in oxygen-helium as compared to oxygen and oxygen-nitrogen atmospheres. Atmospheric moisture conditions required for efficient absorption were defined. Exploratory work indicates partial hydration of the oxide is one method for initiating absorption under low humidity conditions. Gravimetric analysis work, which confirmed that density limitations are presently imposed by reaction product-substrate molar volume relations, should provide useful guidelines for absorbent design and further experimentation. Author (TAB)

N68-17857# Naval Research Lab., Washington, D. C.
ON THE ACTIVITY OF PLATINUM CATALYSTS IN SOLUTION. PART 2: KINETICS OF THE PT-O REACTION WITH HYDROGEN AND OF PT-H DEPOSITION USING A DOUBLE-PULSE TECHNIQUE Interim Report

Theodore B. Warner and Sigmund Schuldiner 1 Dec. 1967 21 p refs
(NRL-6627; Pt. 2; AD-663880)

Surface coverages of oxygen and hydrogen were determined on electrodes of differing activities as a function of time and voltage in the potential decay curve following an anodic pulse. The electrolyte was 1M H2SO4 containing dissolved hydrogen. No important difference, other than rate, is found in the way Pt-O is removed from surfaces of differing activity; however, a significant difference is noted in the way hydrogen resorbs. The rate of Pt-O removal is of apparent first order in adsorbed oxygen when the initial fraction of the surface covered is about 1.0; it is zero order in adsorbed oxygen and amount reacted when the initial surface coverage is less than 0.8. It is zero order in hydrogen partial pressure in both cases. The rate of the decay reaction is probably not limited by mass transport of solution H2 to the surface, by obstruction of active surface sites by sorbed product molecules, or by slow chemisorption of solution H2 on the electrode prior to reaction with Pt-O. Author (TAB)

N68-17874# Aberdeen Proving Ground, Md. Army Coating and Chemical Lab.
QUANTITATIVE MEASURE OF PHOTOCHEMICALLY REACTIVE AROMATIC HYDROCARBONS IN ENAMELS AND THINNERS Interim Report
George G. Esposito Dec. 1967 20 p refs
(CCL-241; AD-663813) CFSTI: HC $3.00/MF $0.65

Recently enacted air pollution abatement laws regulate the amount of photochemically reactive solvents that can be used in paint products. Aromatic solvents possess the strongest solvency of the hydrocarbon types, but their use in paint must now be restricted in order to comply with air contamination laws. This report describes a suitable gas chromatographic procedure for the determination of toluene, ethyl benzene and total aromatics in enamels and thinners. The solvent is isolated by vacuum distillation. High boiling and low boiling internal standards are added and the analysis is conducted on six and eighteen foot columns containing N,N-Bis(2-cyanoethyl) formamide as the liquid. Author (TAB)

N68-17922# Princeton Univ., N. J. Frick Chemical Lab.
THE DAMPED TORSIONAL OSCILLATOR MODEL FOR POLYMER MOLECULES
Arthur V. Tobolsky and Donald B. Du Pre Dec. 1967 26 p refs
(Contract Nonr-1858(07))
(ONR-TR-RLT-101; AD-663703)

An alternative model to the Rouse-Bueche (RB) theory of viscoelasticity is presented, in which the segments are torsional oscillators consisting of two or three backbone links, and the damping is due to hindered internal rotation (DTO model). The mathematical treatment of these two models is essentially identical, but the physical interpretation of the constants used is very different. The DTO model has previously been applied by one of us to the interpretation of viscoelastic data. It is applied to the interpretation of dielectric loss data. It is shown that dielectric measurements in dilute solution should very readily discriminate between the two approaches. Finally it is shown that the relaxation time computed from the DTO model is in very close agreement with published NMR data on poly(propylene) oxide 2025, whereas the RB relaxation time is 1000 times shorter than the experimental result. The postulates of the DTO model appear to be confirmed for this low molecular weight polymer. Author (TAB)

N68-17923# Trinity Coll., Dublin (Ireland). Chemical Lab.
CATIONIC POLYMERIZATION BY PERCHLORIC ACID AND RELATED INITIATORS Final Technical Report, Sep. 1966–Aug. 1967
D. C. Pepper Sep. 1967 13 p refs
(Contract DA-91-591-EUC-4127)
(AD-663844)

The report gives general descriptions and quantitative results of polymerization of styrene and of two related monomers, initiated by perchloric acid, and by carbonium salt initiators. The styrene-perchloric acid polymerization, studied between 25 and -97C, proved particularly informative, and can now be given a very detailed interpretation in terms of a true cationic (not pseudo cationic) propagating species which can undergo alternating terminations and revivals. The molecular weights, which superficially show great complexity of behaviour can be fully accounted for. They are controlled by the termination process and by a process of spontaneous transfer (rejection of the initiator molecule). Above -30 transfer to monomer is of growing importance. Studies with different carbonium-ion salts indicate that higher molecular weights may be obtained by diminution of the spontaneous transfer process when the catalyst anion is less basic. Author (TAB)

N68-17926# Weizmann Inst. of Science, Rehovoth (Israel).
THE ROTATION-TRANSLATION-COUPLING EFFECT IN NOBLE-GAS CRYSTALS CONTAINING MOLECULAR IMPURITIES
H. Friedmann and S. Kimel Apr. 1967 97 p refs
(Contract AF 61(052)-838)
(AFCRL-67-0641; SR-5; AD-663440)

A generalized perturbation theory was developed valid in the case where the perturbation can no longer be considered as small relative to the separation between successive unperturbed energy levels. This is applied to the problem of coupling between the rotational and translational motions of a molecule trapped in a spherically symmetric cell. A representation which is diagonal with respect to the total angular momentum and parity operators has been used, taking advantage of the rotation-inversion symmetry presented by the cell model. It has been found possible to obtain closed expressions for the perturbed energy levels valid in the case of near resonance between rotational and translational frequencies. General expressions for the intensity of rotation-translation transitions have also been derived. A quantitative discussion is given of the effect of finite line width on the position of maxima of hot lines. The theory is applied to the interpretation of the spectra of hydrogen halides trapped in noble-gas crystals. Author (TAB)

N68-17936# Bureau of Mines, Albany, Oreg.
DETERMINATION OF THE HEAT OF FORMATION OF VANADIUM TRICHLORIDE
R. V. Mrazek, D. W. Richardson, H. O. Poppleton, and F. E. Block Mar. 1968 16 p refs
(BM-RI-7096)

The heat of formation of vanadium trichloride was determined at 298.15° K. Measurements were made in a solution calorimeter in which an aqueous hydrochloric acid-potassium dichromate solvent was employed. Data are presented for the heats of solution of vanadium trichloride and the vanadium trioxide "backup" compound, and for appropriate dilution reactions needed to preserve stoichiometry. The resulting heat of formation of vanadium trichloride at 298.15°K was found to be $\Delta H^{\circ}_{298.15^{\circ}K} = -138.98 \pm 0.37$ kcal/g mole. Author

N68-17958# Tyco Labs., Inc., Waltham, Mass.
INTERACTIONS OF ADSORBED ORGANIC LAYERS WITH HYDROGEN ATOMS ON PLATINUM ELECTRODES
S. B. Brummer and Kathleen Cahill Jan. 1968 31 p refs To be presented at the Faraday Soc. Discussion on Electrode Reactions of Org. Compds., Newcastle, Engl., 2–4 Apr. 1968
(Contract N00014-66-C-0210)
(ITR-3; AD-663903)

Coverages of smooth Pt foils with H-atoms in presence of CO and reduced CO2 were investigated in 1 M H2SO4 at 40C.

Compared with H-H interactions, H-CO interactions are repulsive above 0.15 V vs. R.H.E. When Theta-CO is expressed in terms of adsorbed CO molecules, there is apparently no net interaction for potentials < or = 0.15 V. When Theta-CO is expressed in terms of sites occupied, the H-CO interaction is repulsive at all potentials. The H-CO2 interaction is repulsive above 0.20 V but attractive below this potential. The data suggest that the uniform heterogeneity model of H-adsorption on Pt is inadequate and that there are at least two distinct kinds of H-atom sites. Within these adsorption regions, the heterogeneity cannot be explained solely on the basis of an a priori site energy distribution; on type II (strongly bonding) H-sites, the observations are consistent with induced heterogeneity. The H-CO2 interaction at high hydrogen coverages must result from lateral interactions; probably hydrogen-bond formation. Because of these interactions, H-atom charging methods of estimating organic coverage on Pt must be used with caution. The cathodic method is least suspect. Although conventional electrochemical techniques show them to be identical, their interactions with H-atoms prove CO-ads and reduced CO2 to be different species. Author (TAB)

N68-17960# Picatinny Arsenal, Dover, N. J. Feltman Research Lab.

PREPARATION OF POLY (PROPYLENE OXIDE) AND ELUCIDATION OF ITS STRUCTURE

Richard J. Valles Dec. 1967 62 p refs

(PA-TR-3586; AD-663805) CFSTI: HC$3.00/MF$0.65

Poly(propylene oxide) was prepared using an aluminum isopropoxide-zinc chloride catalyst system at a temperature of 70-80C for seven days. The isotactic portion was separated from the atactic, using acetone at low temperatures. The isotactic material, which was optically inactive, was fractionated in an isopropanol-water mixture at 70C. The polymer degraded in air and various polar solvents. However, nonpolar solvents did not cause degrading, and therefore could be used for the various determinations. The viscosity measurements were run in benzene at 25C, the osmotic pressure measurements in toluene at 25C, the vapor pressure osmometry measurements in toluene at 37C, and the gel permeation chromatography measurements in tetrahydrofuran at 25C. One light scattering measurement was run in tetralin at 25C. Author (TAB)

N68-17961# General Dynamics Corp., San Diego, Calif. General Atomic Div.

INTERACTIONS BETWEEN HYDROGEN AND OXYGEN ATOMS AND SURFACES Annual Technical Summary Report, Oct. 1, 1966–Sep. 30, 1967

Joe N. Smith, Jr. 10 Oct. 1967 27 p refs

(Contract AF 49(638)-1435)

(GA-8273; AFOSR-67-2431; AD-662622) CFSTI: HC $3.00/MF $0.65

Experimental studies of the scattering of atomic and molecular beams from the surfaces of freshly deposited AG single crystal films are described. The results of two specific experiments are summarized: (1) The scattering of velocity-filtered beams of A and Xe in the velocity range 23200 < or = sub zero < or = 53300 cm/sec and (2) The scattering of Hd, H2, D2, He3, and He4. From the first experiments it is demonstrated that, contrary to previous assumptions, the details of the scattering process are not obscured by the use of a beam with a large (Maxwellian) distribution of velocities, and the result of the second series of experiments supports an earlier inference from experimental data, i.e., rotational state interactions in the heavier diatomic molecules affect the scattering distribution of these molecules. Author (TAB)

N68-17966# Picatinny Arsenal, Dover, N. J. Explosives Lab.

NMR SPECTRAL ATLAS OF AROMATIC NITRO COMPOUNDS

T. A. E. Richter, M. Warman, and E. Sowinski Nov. 1967 139 p

(PA-TR-3529; AD-663804)

Presented are the high resolution proton magnetic resonance spectra of 124 polysubstituted aromatic mono-, di-, tri-, and tetranitro compounds, scanned at 60 MHz. The spectra were obtained from thionylchloride, deuterated dimentylsulfoxide, or deuterium oxide solutions. Author (TAB)

N68-18025# France. Ministere de l'Air, Paris.

CONTRIBUTION TO THE STUDY OF THE OXYGEN ELECTRODE [CONTRIBUTION A L'ETUDE DE L'ELECTRODE A OXYGENE]

Jean-Claude Sohm Serv. de Doc. Sci. et Tech. de l'Armament 1968 72 p refs In FRENCH *Its* Publ. Sci. et Tech. No. 425

Function of oxygen electrodes is examined in detail, and particular attention is given to the mechanism involved in the transport of oxygen in the neighborhood of the line separating the gas-electrolyte-electrode. At ordinary temperatures it is demonstrated that this mechanism is, more or less, the dissolution of the gas in the meniscus that constitutes the solution either in the solution or where it makes contact with the oxygen electrode. It is found that the local pressure rises with the depth and the accumulation of alkali in the meniscus, and it is noted that the current deposited by an oxygen electrode is a function of the length of the line that it realizes. An attempt to define the line current proved fruitless because the line current is almost independent of the geometry of the electrode and the radius of the menicus, and a qualitative discussion, therefore, is presented following the study of other electrodes of simple geometry. Applications for the development of fuel batteries are considered. Transl. by M.W.R.

N68-18032# Japan Atomic Energy Research Inst., Tokyo. Div. of Physics and Chemistry.

STRUCTURE AND FORMATION OF THE CARBIDES OF URANIUM

Hiroaki Tagawa 1968 29 p refs In JAPANESE; ENGLISH summary

(JAERI-4042) CFSTI: HC$3.00/MF$0.65

The literature on the carbides of uranium is reviewed, including the crystal structures, thermodynamics and formation of the carbides. Mono- and di-carbide of uranium as nonstoichiometric compounds are described, with emphasis on the phase diagram, and the effect of impurities (oxygen and nitrogen etc.) on the lattice dimensions. The conditions for the formation and stability of the carbides are also discussed in their thermodynamics. The mechanism of formation of uranium carbides are considered from the aspect the self-diffusion in the carbides. Author

N68-18041# California Univ., Livermore. Lawrence Radiation Lab.

A HERMETICALLY SEALED, HIGH VACUUM GLASS VALVE

Jack Frazer and Ronald K. Stump 25 Sep. 1967 6 p refs

(Contract W-7405-ENG-48)

(UCRL-50317) CFSTI: HC$3.00/MF$0.65

A hermetically sealed high-vacuum glass valve was designed to automate the vacuum analytical system in a chemistry laboratory using a computer. The valve incorporates a glass body, stainless steel bellows, Teflon plunger and a Viton "O" ring. It is automated by means of a piston and plunger. The shortcomings of a greased stopcock are overcome. The accuracy of vacuum analytical techniques and the utility of vacuum synthesis systems are provided by the valve. NSA

N68-18042# California Univ., Livermore. Lawrence Radiation Lab.

AN AUTOMATED, VARIABLE-TEMPERATURE CONDENSATION TRAP

Ronald K. Stump and Jack W. Frazer 25 Sep. 1967 5 p ref

(Contract W-7405-ENG-48)

(UCRL-50318) CFSTI: HC$3.00/MF$0.65

A variable-temperature cold-trap utilizing liquid N as a low temperature coolant and a resistance thermometer as a detector for temperature control was designed for use in vacuum analytical and synthesis chemistry. The trap consists of a glass U-tube with both legs encased in Cu tubing. Temperature can be varied from −180°C to 100°C. A semi-automatic control is provided or the trap may be computer controlled. NSA

N68-18063# Joint Publications Research Service, Washington, D. C.

CHEMISTRY OF ORGANOPHOSPHORUS COMPOUNDS IN THE KAZAN' SCHOOL OF ORGANOPHOSPHORUS CHEMISTS

A. N. Pudovik and I. M. Aladzheva 6 Mar. 1968 47 p refs Transl. into ENGLISH from Usp. Khim. (Moscow), v. 36, no. 9, 1967 p 1499–1532

(JPRS-44591) CFSTI: HC$3.00/MF$0.65

An important role in advances made in the chemistry of organophosphorus compounds belongs to the Kazan' school of organophosphorus chemists, founded more than half a century ago. In this survey we are not aiming at describing all the research done by Kazan' chemists on organophosphorus compounds (these studies number more than 700), rather we have attempted to trace the development of the fundamental scientific directions of the Kazan' school relating to study of transformations of esters and some other derivatives of trivalent phosphorus in compounds of pentavalent phosphorus, reactions of the addition of organophosphorus compounds with a labile hydrogen atom to compounds having multiple bonds, investigations of the fine structure of organophosphorus compounds by physical and physiochemical methods, synthesis of phosphorus containing insecticides and physiologically active compounds, and preparation of phosphorus containing monomers and polymers based on these compounds. Author

N68-18068*# Techtran Corp., Glen Burnie, Md.

THE DIRECT ADSORPTION OF CO_2 BY QUICKLIME

Yoshio Ohno Washington NASA Mar. 1968 9 p refs Transl. into ENGLISH from Gypsum and Lime (Japan), no. 28, 1957 p 22–26

(Contract NASw-1695)

(NASA-TT-F-11449) CFSTI: HC$3.00/MF$0.65 CSCL 07B

An analysis of the direct reaction between CaO and CO_2 gas to form $CaCO_3$ at 500–700°C was performed to explain the retention of $CaCO_3$ within lumps of limestone after calcining, and the readsorption of CO_2 by CaO upon cooling of the interior of the lumps. A higher volume of CO_2 was adsorbed by CaO which had been calcined at lower temperatures. Glazed quicklime had lower porosity and consequently lower adsorption. Author

N68-18071*# Techtran Corp., Glen Burnie, Md.

INFLUENCE OF TEMPERATURE ON THE PYROLYSIS OF CALCIUM CARBONATE IN AN ISOTHERMAL CONTAINER IN A STREAM OF NITROGEN OR UNDER CONSTANT VACUUM [INFLUENCE DE LA TEMPERATURE SUR LA PYROLYSE DU CARBONATE DE CALCIUM, EN ENCEINTE ISOTHERME, DANS UN COURANT D'AZOTE OU SOUS VIDE ENTRETENU]

Jean-Paul Auffredic and Pierre Vallet Washington NASA Jan. 1968 7 p refs Transl. into ENGLISH from Compt. Rend. Acad. Sci. (Paris), v. 265, ser. C, 7 Aug. 1967 p 329–332

(Contract NASw-1695)

(NASA-TT-F-11435) CFSTI: HC$3.00/MF$0.65 CSCL 07B

Pyrolysis of a block of calcium carbonate is studied. Pyrolyses were carried out in a stream of nitrogen and under constant vacuum. Expressions are developed for the reaction rate constants, and the activation energy is determined. Pyrolysis is much more rapid under constant vacuum than in the stream of nitrogen. Author

N68-18073# Columbia Univ., New York. Dept. of Chemistry.

ELECTRON SPIN RESONANCE OF FREE RADICALS Final Scientific Report, 1 May 1963–31 Jul. 1967

George K. Fraenkel Dec. 1967 29 p refs

(Grants AF-AFOSR-285-63; AF-AFOSR-285-65; AF-AFOSR-285-67)1148

(AFOSR-68-0060; AD-663740)

Summaries are given of the individual projects of a program intended to apply ESR spectroscopy to the determination of molecular wavefunctions of organic free radicals from measurements of the isotropic hyperfine interaction with protons, carbon-13, and other magnetic nuclei. TAB

N68-18084*# General Dynamics/Convair, San Diego, Calif. Space Science Lab.

BAND MODEL REPRESENTATIONS FOR HIGH TEMPERATURE WATER VAPOR AND CARBON DIOXIDE

C. B. Ludwig and W. Malkmus *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 19–35 refs (See N68-18082 08-33)

The properties of symmetric and asymmetric top molecules relevant to the structure of the vibration–rotation band systems are briefly discussed. The derivation of analytic expressions for the local line intensities and spacings of symmetric top molecules as functions of frequency is described. Further approximations necessary to apply this procedure to asymmetric top molecules are described, and results are shown for H_2O. The relationships of the calculated parameters to particular band models and the properties of these band models are discussed. The long-burner program for measurement of emissivities of gases at high temperatures and long path lengths is described and compared with other experimental work. Results for twenty-foot path lengths are discussed. Inhomogeneous path measurements are described and comparisons with calculated spectra are shown. Author

N68-18133*# National Aeronautics and Space Administration, Washington, D. C.

THE PROBLEM OF ELECTROLYTIC METAL OVERPOTENTIAL [ZUR FRAGE DER ELEKTROLYTISCHEN METALLUEBERSPANNUNG]

T. Erdey-Gruz and M. Volmer Feb. 1968 13 p refs Transl. into ENGLISH from Z. Physik. Chem. (Frankfurt), v. A157, no. 3-4, 1931 p 165–181

(NASA-TT-F-11512) CFSTI: HC$3.00/MF$0.65 CSCL 07D

Several characteristics that theoretically arise from the various possibilities of the partial velocity-determining process in electrolytic metal dissociation are discussed. Based on the experimentally-obtained current-voltage curves and the photomicrographs, the role of the active areas is pointed out and a qualitative interpretation of metal dissociation is given. Author

N68-18143 Laboratoires du Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).

RESULTS OF SUBCRITICAL EXPERIMENT TESTS ON A WATER URANIUM OXIDE SYSTEM ENRICHED WITH 5% [RESULTATS D'EXPERIENCES SOUS-CRITIQUES REALISEES SUR DES RESAUX H_2O–UO_2 ENRICHIS A 5%]

J. Debrue, L. Mewissen, F. Motte, J. Basselier, R. Delrue et al Brussels EURATOM 1967 In FRENCH Prepared jointly with Soc. Belge pour l'Ind. Nucl.

(Contract EURATOM-001-64-1 TRUB)

(EURAEC-1882; EUR-3378.f) CFSTI: $3.00

Subcritical experiments are reported for water–uranium dioxide system enriched with 5% uranium 235. Computer printouts are included for measures obtained as a function of circular charge at H_2O/UO_2=2.63, 4.13, 6.33, and 9.35; as a function of boric acid poisoning for the circular lattices at 2.63, 4.13, and 9.35; and

as a function of the number of microtubes for the circular lattices at 4.13. Conditions for the various experimental results are tabulated, and details are given for all the measures of neutron pulsations and the injection source. Representations are included for the transverse sections following for five subcritical lattices for the principal configurations. Transl. by M.W.R.

N68-18171# Naval Research Lab., Washington, D. C.
DIMETHYL SULFOXIDE COMPLEXES OF CHROMIUM (3), MANGANESE (2), IRON (3), NICKEL (2), AND COPPER (2) NITRATES AND MAGNESIUM AND NICKEL (2) PERCHLORATES. PART 1: PREPARATION AND NUCLEAR MAGNETIC RESONANCE AND INFRARED STUDIES Final Report
W. B. Moniz, C. F. Poranski, Jr., and D. L. Venezky 18 Oct. 1967 43 p refs
(NRL-6597, Pt. 1; AD-663552)

Dimethyl sulfoxide ((CH3)2SO, DMSO) complexes of Cr(NO3)3, Mn(NO3)2, Fe(NO3)3, Co(NO3)2, Ni(NO3)2, Cu(NO3)2, Ni(ClO4)2, and Mg(ClO4)2 were prepared and investigated using infrared and nuclear magnetic resonance (nmr) spectroscopy. The infrared data indicate that the ligand forms a coordinate bond to the metal through the oxygen atom in all of the complexes, and that the tetranitrato-metal anion is present in Mn(NO3)2.3DMSO, Co(NO3)2.3DMSO, and Cu(NO3)2.3DMSO. The nmr spectra of Mn(NO3)2.3DMSO, Co(NO3)2.3DMSO, Ni(NO3)2.4DMSO, and Cu(NO3)2.3DMSO in DMSO solutions were analyzed in terms of contact shifts, and electron-nuclear hyperfine coupling constants. The results correlate with the covalent-bond strengths of the metal atoms and fit a model for electron-spin delocalization via the sigma-bond system of the complexes. Attempts to utilize liquid SO2 as a solvent for the nmr studies were hampered by a reaction between SO2 and the nitrate ion. Literature references to DMSO complexes and to techniques used in their study are presented in two appendixes. Author (TAB)

N68-18217*# Pennsylvania Univ., Philadelphia. Electrochemistry Lab.
STUDIES IN FUNDAMENTAL CHEMISTRY OF FUEL CELL REACTIONS Semiannual Progress Report, 1 Jul.–31 Dec. 1967
John O'M. Bockris 31 Dec. 1967 127 p refs
(Grant NsG-325)
(NASA-CR-93364; SAPR-11) CFSTI: HC $3.00/MF $0.65 CSCL 07D

The application of ellipsometry to the study of ion adsorption on mercury is discussed, and a comparison of the results with those obtained by electrocapillary measurement shows satisfactory agreement. A rebuttal is presented to criticism on previously obtained data pertaining to the potential of zero charge on platinum, and an attempt is made to explain the discrepancies in the two values. Also discussed are the continuing studies on the trajectory of motion and the potential energy barrier for an ion in an ionic lattice moving under the influence of an electric field. Theoretical considerations on the reversibility of organic reactions are discussed, and data are given on several organic compounds investigated by means of the potential sweep method. A publications bibliography is included. M.G.J.

N68-18219*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
LATTICE STRUCTURES IN SOLUTIONS
Joseph S. Rosen Washington Mar. 1968 17 p refs
(NASA-TN-D-4297) CFSTI: HC $3.00/MF $0.65 CSCL 07D

The concept of an irregular and random arrangement of ions in solution is rejected. The interionic distances of the crystal lattice structure, assumed to be retained in solution, are maintained by the equilibrium between cohesive and repulsive forces on the ions in solution. This concept of a lattice structure in solution may have an important relation to the theory of an ionic atmosphere in electrolytic solutions. Calculations are presented for various concentrations of the alkali halides; for concentrations when no water is present, the interionic distances for the alkali halides agree with results obtained by other methods. Author

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N68-17250# Weapons Research Establishment, Salisbury (Australia)
DATA TRANSMISSION ON CABLE CIRCUITS ASSOCIATED WITH EQUIPMENT CENTRE 6 LAKE HART, WOOMERA, AUSTRALIA
R. D. Ramsay May 1967 37 p
(WRE-TN-EC-27)

In order to verify the characteristics and determine the capabilities of the standard cable circuits feeding data to and from Equipment Centre 6 at Lake Hart various tests have been carried out. Thus, the aims of this note are: (1) to compare parameters of typical cable circuits, feeding data signals to and from Equipment Centre 6, with specification WRE 232 (Characteristics of the Woomera Communication Network), (2) to show the capabilities of the links for simple data transmission systems, and (3) to illustrate the operation of the link with specific examples. Author

N68-17251# Weapons Research Establishment, Salisbury (Australia)
ELECTRICAL CHARACTERISTICS OF A ROYAL AUSTRALIAN NAVY EXPERIMENTAL LABORATORY HYDROGRAPHIC CABLE
R. D. Ramsay May 1967 20 p
(WRE-TN-EC-30)

This technical note concerns an investigation carried out on a four-core hydrographic cable in order to determine its main electrical characteristics. The characteristics investigated were line constants, characteristic impedance, attenuation, crosstalk and square wave response. Author

N68-17310# Weapons Research Establishment, Salisbury (Australia)
ON THE OBLIQUE PROPAGATION OF HF RADIO WAVES VIA THE IONOSPHERE
P. L. George Apr. 1967 20 p refs
(WRE-TN-CPD(T)-135) CFSTI: HC $3.00/MF $0.65

Equations are derived for the group path, phase path, height of reflection, time of flight and ground range pertaining to a single spherically stratified ionosphere layer having no imposed magnetic field. The method of solution of the equations for a layer having an arbitrary electron density/height distribution is indicated. The equations are solved explicitly for a parabolic model ionosphere. Author

N68-17412# Sandia Corp., Albuquerque, N. Mex.
AN INVESTIGATION OF TRANSMISSION LINE APPROXIMATIONS FOR THE PROPAGATION OF MICROWAVES THROUGH DIELECTRIC LAYERS
L. W. Zelby, A. J. Russo, and S. G. Beard Jan. 1968 47 p refs
Sponsored by AEC
(SC-RR-67-2948)

The plane-wave and transmission line theories often used in analysis of the interaction of electromagnetic radiation with a stratified plasma were applied to the interaction of an antenna with a dissipative medium in its near field. The input impedances of an open waveguide and an exponential horn which were terminated with a dissipative dielectric were measured and calculated at x-band frequencies. Comparisons were also made between the measured and computed signal attenuation. Portions of the analysis included near-field interaction effects and are applicable to any aperture antenna. Author

N68-17542*# Israel Program for Scientific Translations, Ltd., Jerusalem.
MEASUREMENT OF PULSE DISTORTION IN DIGITAL INFORMATION TRANSMISSION
K. A. Brusilovskii 1968 96 p refs Transl. into ENGLISH of the publ. "Izmereniya Iskazhenii Impul'sov v Sistemakh Peredachi Diskretnoi Informatsii" Moscow, Izd. Nauka, 1965 p 1–92 Published for NASA and NSF
(NASA-TT-F-434; TT-67-51370) CFSTI: HC $3.00/MF $0.65 CSCL 09D

Theoretical analyses of various problems connected with digital data channel measurements are presented, along with the statistical features of noise distortion and error distribution in communication channels. Evaluation criteria are developed for the noiseproof features of communication channels and for elements in the statistical treatment of signals, noises, distortions, and errors in digital data transmission systems handling uniformly coded binary data. A mathematical model is formulated for error analysis in such systems. The fundamental properties and generation of test signals are described, and design criteria are given for noncontact, solid-state, switching element transistor and ferrite measuring instruments. Questions relating to the optimum design of a digital indicator register and a transistorized output relay are discussed. A bibliography of related works is included. E.J.S.

N68-17547*# Advanced Technology Corp., Timonium, Md.
STUDY PROGRAM ON (30–100 GHZ) ELECTRONICALLY STEERABLE ANTENNA SYSTEMS Quarterly Report, 20 Jul.–20 Oct. 1967
John M. Cotton, Jr. and Dennis E. Grimes 20 Oct. 1967 31 p
(Contract NAS5-10256)
(NASA-CR-93290; QR-5) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Summary results are presented on experimental work conducted on various aspects of the antenna system. Several series feed system problems are discussed in relation to fabrication and experimental developments. A major problem encountered in respect to the auxiliary arm coupling by broadwall slots was that the power being coupled out exceeds the power being coupled through. The quasi-optical power distribution system is discussed in relation to two components, the sensed illuminating horn and the input array. Calculations for the optical feed system include power expectations from a 49-element uniform array, and compensated nonuniform array of horns. B.S.D.

N68-17615*# Technical Communications Corp., Lexington, Mass.
EVALUATION OF CSE MODEM FOR AIRCRAFT TERMINAL MULTIPLE ACCESS TO COMMUNICATIONS/NAVIGATIONAL SATELLITES Final Report
15 Dec. 1967 50 p refs
(Contract NAS5-10255)
(NASA-CR-93288; R67-112) CFSTI: HC $3.00/MF $0.65 CSCL 17B

The objective of this program was to analyze and construct experimental equipment for the application of "CSE" modulation to aircraft satellite communications. CSE modulation is essentially linear swept FM, used as a subcarrier for multiple-access communications. The following two modes of operation were analyzed: (1) at 2400 bps (a typical vocoder rate); and(2) at 75 bps (a typical teletype rate). Both modes of operation used a 50 kHz bandwidth and a transmitter center frequency of about 150 MHz compatible with the ATS-1 VHF satellite. The experimental modulator was designed to interface with a VHF transmitter at ground station, and the experimental demodulator was designed to interface with an aircraft receiver using an 18 MHz intermediate frequency(IF). Analytical and laboratory results confirmed the value of CSE modulation in dispersive channels and the feasibility of implementing it. Author

N68-17738# Scanwell Labs., Inc., Springfield, Va.
VORTAC PERFORMANCE IN A SNOW AND ICE ENVIRONMENT Final Report
Clinton G. Hollins Feb. 1968 138 p refs
(Contract FA-65-WA-1316)
(SRDS-RD-68-3)

Investigations into the performance of VORTAC installations operating in an adverse snow and ice environment are described. VOR system performance is analyzed using a computational program for determining the course errors produced by sections of a thin spherical shell centered on the antenna system. A near field formulation of the electro-magnetic problem allows simultaneous computation of the course error curves for both ground checks and aircraft orbits. Specific examples of course error curves and graphical summaries of the variation in maximum course error as the parameters describing the scatterer are altered provide a foundation for discussion of the more significant distributions of snow. Natural accumulations are shown to be capable of producing out-of-tolerance conditions accompanied by inadequate monitoring. Possible solutions for the problem are briefly discussed. The results of thermal tests performed on a TACAN transmitting antenna in order to determine the deficiencies present in the existing deicing system are evaluated. Modifications of the TACAN and VOR monitor antennas which will eliminate unwarranted outages due to ice and snow accumulation on the antenna covers are described along with the results of tests on the modified equipment. Author

N68-17781# Naval Research Lab., Washington, D. C.
SOME BASIC ASPECTS OF RADAR TARGET IMAGING Interim Report
Henry A. Brown 15 Nov. 1967 33 p refs
(NRL-6623; AD-663554)

The classical basis of resolution as applied to radar target imaging was investigated with reference to point source targets in one dimension and their associated images. The imaging process can be represented by a Fourier integral operation on modified planar aperture data; two methods of evaluating this integral by a digital computer are linear interpolation and Filons method. Curves were prepared which illustrate the aperture-resolution relationship and the sampling element placement within the aperture. Image distortion due to finite aperture size and to approximations of the far-field phase were examined by generating point source images on a computer and found to be distorted both in peak position and amplitude for finite apertures. Although phase correction for the distance between the constant-range surface and the planar aperture was shown by example to be essential for imaging, useful images can be obtained by such crude approximations as making plus or minus phase assignments to alternate lobes of the far-field pattern. Author (TAB)

N68-17832# Illinois Univ., Urbana. Coordinated Science Lab.
LATTICE CODING FOR CONTINUOUS CHANNELS
Robert J. Tracey Dec. 1967 85 p refs
(Contract DAAB07-67-C-0199)
(R-371; AD-663808)

A class of explicit codes for time-discrete amplitude-continuous channels is presented. These codes, called lattice codes, can

maintain positive transmission rates over such channels while simultaneously reducing the probability of error to zero, providing only that the channel noise variance is finite. A lattice in n-dimensional Euclidean space is the set of all integer linear combinations of some n independent basis vectors. A lattice code for a given time-discrete amplitude-continuous channel is formed from a lattice by taking for codes words all those vectors of the lattice which satisfy the channel constraints. Communication over memoryless time-discrete amplitude-continuous channels with either amplitude or average power constraints using lattice codes is considered. An analysis is given for such channels when lattice codes are used together with bounded distance decoding. Bounds on the channel capacity are found, and for fixed transmission rates less than capacity, bounds are found for the best attainable probability of error as a function of the code length n. The construction of lattice codes using positive definite quadratic forms is considered. A sequential decoding algorithm which has a probability of error less than that of bounded distance decoding for any lattice code is given. Finally, some examples are given of lattice codes for which this algorithm may be replaced by a simple algebraic procedure. Author (TAB)

N68-17836# Stanford Univ., Calif. Radioscience Lab.
POLARIZATION OF IONOSPHERICALLY PROPAGATED WAVES
Mark R. Epstein Oct. 1967 120 p refs
(Contract Nonr-225(64); ARPA Order 196-67)
(SU-SEL-67-091; TR-143; AD-663707)

The theory of wave propagation in the ionosphere, supported by experimental measurements, is used to demonstrate that regular amplitude variations in HF sweep-frequency oblique-ionogram one-hop rays - when linearly polarized receiving antennas are employed - are due to corresponding variations of the received wave polarization with radio frequency. Over quasi-longitudinal paths the rate of occurrence of these variations with frequency (at some instant of time) was found (using computer raytracing techniques) to increase with increasing radio frequency and path length, and with increasingly close alignment of the propagation path with the longitudinal component of the earths magnetic field. In addition, this rate is shown to be proportional to the group propagation-time difference between the two magnetoionic wave components at a given frequency. This relation explains certain remarkable features of the rate of occurrence of the variations. Experimental measurements demonstrate that the position in the spectrum of the observed amplitude maxima moves with time in a manner consistent with individual-mode polarization rotation with time at a given frequency. An experimentally determined statistical description of this behavior is obtained for winter-noon conditions. Polarization fluctuations of received ionospherically propagated waves are proposed as potentially useful indicators of the occurrence and location of ionospheric disturbances. Author (TAB)

N68-17842# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ELECTROAUTOMATION OF SHIP AND AIRCRAFT RADAR STATIONS
V. M. Artamonov 1 May 1967 487 p refs Transl. into ENGLISH from the book "Elektroavtomatika Sudovykh i Samoletnykh Radiolokatsionnykh Stantsiy" Leningrad, 1962 p 1–363
(FTD-MT-64-352; AD-663870)

The book considers the basic forms of electroautomation of ship and aircraft radar stations, their assignment and the requirements presented to them. Information is presented about the interaction of elements and systems of electroautomation with radio sets and control instruments; the construction of the mechanisms of antenna systems is described. The material expounded in the book is accompanied by a large number of practical examples and calculations. The book is a training aid for electronics schools; it will be useful to students of electronics departments of higher educational institutions and technicians studying the production and operation of radar stations. Author (TAB)

N68-17859# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
COMMUNICATIONS RESEARCH STUDY (METHODS OF EVALUATION) Final Report
C. P. Reeves May 1967 1 p refs Prepared for Office of Civil Defense
(CAL-VP-2269-H-5; AD-663817)

A report is submitted on a study to develop methods for evaluating the capability of civil defense communication systems to meet operational requirements during and after thermonuclear attack. Findings of past research were reviewed to determine typical communications systems at regional, state and local levels and to ascertain the probable effects of nuclear weapons on these systems. Alternative evaluation techniques were reviewed for applicability to civil defense communications systems. An integrated evaluation method was developed which would make use of engineering analysis, field operations and computer simulations. This method would permit the correlation of pre-strike system characteristics with post-strike system performance, thus providing a basis for the specification of reference or minimum standard civil defense communications systems against which real-world systems might be evaluated. An interim method for evaluating local civil defense communications systems by means of engineering analysis was also developed. Author (TAB)

N68-17871# Naval Research Lab., Washington, D. C.
THEORETICAL VLF MULTIMODE PROPAGATION PREDICTIONS
C. B. Brookes, Jr., J. H. McCabe, and F. J. Rhoads 1 Dec. 1967 90 p refs
(NRL-6663; AD-663878)

A computer program in Fortran has been written for the Control Data Corporation (CDC) 3800 computer to predict the field strength of multimode very-low-frequency (vlf) propagation for distances from 0.5 megameters to 15 megameters. Although the propagation parameters used in the computations appear in various forms elsewhere in the literature, the curves presented here can be directly compared with experimental data without further computations. Curves based on the theoretical results for seawater paths are presented for frequencies between 8.0 kc/s and 30.0 kc/s for ionospheric heights of 70 km and 90 km. Author (TAB)

N68-17875# Chesapeake Systems Corp., Cockeysville, Md.
SUB-SEQUENCE CORRELATION ANALYSIS Final Report, 20 Dec. 1966–19 Oct. 1967
A. Brinton Cooper and Peter H. Lord Griffiss AFB, N. Y. RADC Dec. 1967 97 p refs
(Contract F30602-67-C-0128)
(R-67-16; RADC-TR-67-591; AD-663738)

One method of synchronizing a communication system uses the cross correlation between a maximal length pseudorandom, binary sequence and a portion of that sequence. Using only part of the sequence causes the correlation function to have peaks when the sequences are not aligned, and thus may cause a threshold decision scheme to synchronize incorrectly. An analysis was performed on the synchronization process by which a maximum length, linear, pseduorandom binary sequence is cross correlated with a very short sample of itself until correlation occurs. The object of the analysis was to determine which of many available pseudorandom sequences of a given length would be least likely to cause abnormally large correlator outputs in the un-correlated state. A second and equally important goal was the specification of the optimum decision threshold to be used to achieve a minimum probability of false indication of synchronism while maintaining a uniformly low probability of falsely dismissing the correct synchronous state. The investigation centered upon several theoretically derived hypotheses concerning the sequence generating functions and upon the experimental verification of these hypotheses. Data accumulated during the latter effort was used to calculate the optimum thresholds for the noise-free and the noise-present cases. Author (TAB)

N68-17885*# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
COMMUNICATION OVER FADING DISPERSIVE CHANNELS
John S. Richters 30 Nov. 1967 196 p refs
(Grant NsG-334)
(NASA-CR-93249, TR-464) CFSTI: HC $3.00/MF $0.65 CSCL 17B

The transmission of digital information over a fading dispersive channel is considered, subject to a bandwidth constraint on the input signals. A specific signaling scheme is proposed, in which information is transmitted with signals formed by coding over a set of smaller basic signals, all of which excite approximately independent and orthogonal outputs. The problem is then modeled as one of block coding over successive independent uses of a diversity channel. Upper and lower bounds to the minimum error probability attainable by such a scheme are derived. These bounds are exponentially decreasing in terms of the time available for information transmission, and agree asymptotically for a range of rates. These bounds are used to interpret the significance of different signal and channel parameters, and the interplay between them. Some conclusions are drawn concerning the nature of good input signals, the major one being that any basic signal should be transmitted at one of a small number of discrete voltage levels. Several numerical examples are included, to illustrate how these results may be applied in the estimation of performance levels for practical channels. Author

N68-17890# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CERTAIN QUESTIONS OF TELEMETRY OF PARAMETERS IN SYSTEMS WITH DISPERSED OBJECTS [NEKOTORYYE VOPROSY TELEIZMERENIYA PARAMETROV V SISTEMAKH S RASSREDOTOCHENNYMI OB'YEKTAMI]
V. I. Kurotchenko and N. I. Babanin 16 Jun. 1967 28 p refs
Transl. into ENGLISH of the Mono. "Primeneniye Veskontaktnykh Elementov v Sistemakh Avtomaticheskogo Kontrolya" Frunze, Izd. AN Kirgiz. SSR, 1963 p 1–17
(FTD-MT-65-82; AD-663915)

Automatic control of irrigation systems is considered. Although telemetering systems are usually developed to meet concrete requirements of a specific installation, unified systems for related elements are also possible. Existing systems are classified according to signal type (continuous or discrete) and means of modulation (pulse-time, pulse-phase, frequency, pulse-code, frequency-code, etc.) for purposes of communications transmission and determination of input parameters for systems with dispersed elements. It is found that a discrete signal pulse-code system is best. Among the advantages of this type of system are ease of combination with digital remote-control machines and contactless RC signal systems, economy of manufacture, small dimensions, adaptability to use of semiconductors and magnetic elements eliminating moving parts and contacts, reliability and durability. Angle of code shaft revolution is chosen over voltage or current for the parameter input factor, as less subject to distortion and error. A system of this type developed by the authors (BKT-62) is described in outline, circuit by circuit, with block diagrams and extensive schematics. Industrial testing has shown high operating qualities, and the system has been recommended as the standard for irrigation systems. Author (TAB)

N68-17914# Conductron Corp., Ann Arbor, Mich.
CALCULATION OF ELECTROMAGNETIC FIELDS IN THE FOCAL REGIONS OF A PARABOLOID RECEIVING OFF AXIS Final Report, Jan. 16–Aug. 15, 1967
Irvin W. Kay 15 Aug. 1967 180 p refs
(Contract F19628-67-C-0219)
(AFCRL-67-0486; AD-663743)

The electromagnetic field due to the diffraction by a paraboloidal reflector of a plane wave incident off-axis is calculated at a number of points in the caustic regions. The field calculations are made by evaluating the associated Debye-Picht-Luneberg diffraction integrals with the aid of a high speed digital computer. Four cases are considered in which the incident propagation vector makes angles of 0 degrees, -10 degrees, -20 degrees, and -28.4 degrees with the paraboloidal axis. For each case the electric and magnetic fields calculated at points lying in two planes, one containing the paraboloidal axis and the other passing through the paraboloidal focus but perpendicular to the first plane. The points where the fields are calculated, relative to the intersections of the caustic surfaces with each of the two planes, are illustrated in a series of figures drawn to scale. Author (TAB)

N68-17916# RAND Corp., Santa Monica, Calif.
AN ANALYSIS OF COST *VERSUS* PERFORMANCE RELATIONSHIPS FOR PHASED ARRAY RADARS
L. A. Rondinelli Nov. 1967 87 p
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5380-PR; AD-663732)

Cost estimating relationships between the performance requirements of phased array radars and their hardware and installation cost are developed for both the search and tracking functions. Appropriate performance parameters for each function are derived from system operational requirements, and Lagrange multipliers are used to obtain the optimum design formulas and minimum-cost equations. Results of several phased array cost examples are analyzed to test the sensitivity of the cost estimates to variations in required system performance and in the cost coefficients of the cost equations. The use of higher power modules at lower cost per watt results in less expensive search arrays. For tracking array designs, the situation is reversed. By a compromise design, the same array can be used for both functions. Author (TAB)

N68-17924*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A MILLIMETER WAVE PROPAGATION EXPERIMENT FROM THE ATS-E SPACECRAFT
J. W. Dees, J. L. King, and J. C. Wiltse [1967] 10 p Presented at IEEE, Group on Microwave Theory and Tech., New York, 18–21 Mar. 1968
(NASA-TM-X-60763) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Instrumentation is described for a millimeter wave propagation experiment to be performed with the Applications Technology Satellite-E. Wideband signals near 15.3 and 31.65 GHz will be transmitted between the spacecraft and several ground stations, and attenuation and phase distortion effects caused by the atmosphere and meteorological phenomena will be measured. The objective is to obtain propagation data at varied ground locations for a variety of weather conditions, including seasonal variations. Details of both the ground station and spacecraft millimeter wave equipment are described. Author

N68-17928# Columbia Univ., New York. Electronics Research Labs.
PEAK-AVERAGE AND AVERAGE-PEAK RADAR CROSS SECTIONS OF WAKES (OR CHAFF)
I. Weissman 27 Oct. 1967 10 p
(Contract AF 49(638)-1478; ARPA Order 279)
(TM-6/331; AD-663432)

Expressions are given comparing the peak-average to average-peak radar cross section for random distributed scatterers such as re-entry wakes or chaff. In order to relate the peak-average (which is a conventional measure) to the average-peak (which is more-simply determined), the form and extent of the scatterer must be known. Ratios of these quantities are computed for three different forms of average pulse shape: uniform, triangular, and exponential. Author (TAB)

N68-18017# Federal Aviation Administration, Atlantic City, N. J. Dept. of Transport.

RLT/FM BROADCAST INTERFERENCE STUDY Final Report

Henry E. Scozzafava Dec. 1967 21 p

(NA-67-16; RD-67-44) CFSTI: HC $3.00/MF $0.65

Interference signal ratios were measured by laboratory tests to determine: (1) the level of VOR test signal at 108.0 MHz that could be tolerated in various FM broadcast receivers without audible interference, and (2) the level of FM broadcast signal at 107.7 and 107.9 MHz that could be tolerated in various VOR airborne receivers without causing an indicated course shift greater than ±0.5 degree or a change in course sensitivity greater than 10 per cent. The degree of interference was sufficient to recommend that the data be used to establish geographical separation criteria between Radio-navigation Land Test stations and FM broadcast stations for frequency assignments. Author

N68-18020# Joint Publications Research Service, Washington, D. C.

DIGITAL SIGNAL DETECTION EQUIPMENT

A. N. Romanov 28 Feb. 1968 10 p Transl. into ENGLISH from Vestn. Protivovozdushnoy Oborony (Moscow), no. 12, Dec. 1967 p 74–78

(JPRS-44520) CFSTI: HC $3.00/MF $0.65

Schematics and system design details are given on a circular scanning radar which includes a synchronizer, transmitter, antenna switch, and an indicator. The radar also includes an automatic data plotting device consisting of a preselector and a device for digital determination of range and azimuth. The operating characteristics of the automatic data plotting device are defined as the separation of the useful signal against background of unavoidable noise, and signal processing with respect to the threshold and position. The storing process during entire scanning cycle is performed by a digital computer memory; thus the functions of separation of the signal, measurement of the coordinates, and data storage are separate. B.S.D.

N68-18036*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.

THE CURRENT AND NEAR FIELDS OF AN INFINITE CYLINDRICAL ANTENNA IMMERSED IN A LOSSY PLASMA MEDIUM Scientific Report

Edmund K. Miller Dec. 1967 99 p refs

(Contract NASr-54(05))

(NASA-CR-93357; Rept.-05627-14-S) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The surface currents and near fields of an infinite cylindrical dipole antenna excited at a circumferential gap of non zero thickness and immersed in a lossy plasma medium which may be in the general case both compressible and anisotropic, there being a static magnetic field parallel to the antenna axis, are numerically investigated. The analysis proceeds from the linearized fluid equations for the electrons (ion motion is neglected) together with Maxwell's equations, and attempts to account for the actual inhomogeneous ion sheath which forms about a body at floating potential in a warm plasma by including in some of the results a concentric free-space layer, or vacuum sheath, between the antenna and the external uniform plasma. Fourier integrals are obtained for the various field quantities involved and are in particular examined numerically for the antenna current and the near electric field for parameter values typical of the E region of the ionosphere. Author

N68-18052*# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.

WAVEFRONT STATISTICS IN 3.2-MM LINE-OF-SIGHT TRANSMISSION

Glenn R. Heidbreder and Richard L. Mitchell Oct. 1967 32 p refs

(Contract F04695-67-C-0158)

(TR-0158(3230-46)-2; SAMSO-TR-67-120; AD-663412)

An experimental study of wavefront statistics in 3.2-mm wavelength CW transmission is described. The measurements were obtained on a 19-km horizontal path near sea level. Two receiving installations were used. One of these is an interferometer with variable element spacing along a horizontal baseline. Signal amplitudes at both elements and phase difference were recorded. Phase difference statistics and amplitude fluctuation correlations were obtained for station separations between 1 and 7 m under various meteorological conditions. The other receiving installation, which may be operated simultaneously with the interferometer, consists of a 4.57-m paraboloidal antenna and radiometer. The main beam of the antenna is 2.8-arc-min wide in free space and is measurably perturbed in a turbulent atmosphere. It may be scanned across a point source in a time short relative to the time constant of the atmospheric structure. The peak relative pointing error of 2.5 arc-sec is sufficiently small that sequences of rapid-scan instantaneous antenna patterns may be superposed to obtain statistics of the pattern. Statistics of beam-wander and average antenna patterns are presented. Statistics obtained with the two receiving installations are compared with each other and with existing theoretical results. Author (TAB)

N68-18055# Philco-Ford Corp., Philadelphia, Pa. Communications and Electronics Div.

DIGITAL COMBINER STUDY Final Report, Sep. 1966–Aug. 1967

Samuel B. Wenzel, Bruce G. Cramer, Andrew R. Harcar, Jay F. Leonard, and Charles A. Hauer Griffiss AFB, N. Y. RADC Dec. 1967 328 p refs

(Contract F30602-67-C-0032)

(DC-66-5; RADC-TR-67-520; AD-663748)

The report analyzes the effect of the troposcatter medium on transmission of analog and high-speed digital data signals, with emphasis on the latter. Solutions to alleviate the problems are proposed. Principal results are given in equations, design curves, and in other specific data forms useful in troposcatter system design. Performance limitations posed by the medium to conventional differential coherent phase-shift-keyed (DCPSK) and frequency-shift-keyed (FSK) system are examined. Signals processing techniques, specifically designed to alleviate the deleterious effect of multipath time spread, are proposed. The performance of various signal-processing techniques is examined and results are compared. A recommended approach is a frequency hopping system using quaternary PSK modulation. Another is the adaptive statistical detector. This looks promising but requires additional development effort; hence, it would represent the next generation of tropo modems. A survey and study of conventional diversity techniques including maximal ratio, equal gain, and switching is made. Performance (under realistic conditions) of each type is considered. This includes an analysis of predetection versus post-detection operation. Author (TAB)

N68-18070*# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Electrical Engineering.

NONPARAMETRIC DETECTION USING EXTREME-VALUE THEORY

Laurence B. Milstein (Ph.D. Thesis), Donald L. Schilling, and Jack K. Wolf [1967] 87 p refs

(Grant NGR-33-006-020; Contract AF 49(638)-1600)

(NASA-CR-93261; T-4) CFSTI: HC $3.00/MF $0.65 CSCL 09D

This paper concerns itself with the detection of a binary signal in additive, but statistically unknown, noise. The signal will be either a constant signal, or a slowly fading signal. The noise will be arbitrary except for the one restriction that its probability

density function exhibit some type of exponential behavior on its "tails". The detector will be based upon Gumbel's extreme-value theory (EVT). This theory will be used to obtain estimates of the optimum threshold and the probability of error of a binary detector. A comparison is made between the EVT detector and another non-parametric detector on which is based the rank test. It is shown that in certain situations, the EVT detector becomes identical to the Neyman–Pearson detector, and therefore will outperform the rank or any other nonparametric detector. Finally a study is made for the case of detecting a constant signal in additive noise and of the detector performance when the learning period is removed. It is shown that for lower error rates, the estimates will converge to values close to those obtained when the learning period is present. Author

N68-18078# Lincoln Lab., Mass. Inst. of Tech., Lexington.
THE GENERAL RESEARCH PROGRAM
15 Jun. 1967 38 p
(Contract AF 19(628)-5167)
(DOR-533; ESD-TR-67-323; AD-663428)

The report is a summary of Lincoln Laboratory's current program of General Research which is a source of new technology for projects of Lincoln Laboratory, the Department of Defense, and other federal agencies. The report covers research in Solid State, Data Systems, Radio Physics, and Communications. Author (TAB)

N68-18123*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE APERTURE ADMITTANCE OF A GROUND-PLANE-MOUNTED WAVEGUIDE ILLUMINATING A PERFECTLY CONDUCTING SHEET
J. Earl Jones and C. T. Swift Washington Mar. 1968 52 p refs
(NASA-TN-D-4366) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The Fourier transform technique is applied to derive an expression for the aperture admittance of a ground-plane-mounted, transverse electric and magnetic (TEM) mode-excited parallel-plate waveguide illuminating a perfectly conducting sheet. Based on the aperture admittance expression, an equivalent circuit is developed. It is shown that there is a 1:1 correspondence between elements of the equivalent circuit and higher order modes which exist in the parallel-plate waveguide formed by the ground plane and the reflecting sheet. For the special case where the configuration is treated as a microwave circuit tee junction, the waveguide widths which give the best impedance match are seen to be 0.04 wavelength for the feed guide and 0.03 wavelength for the second guide. Numerical computations of the reflection coefficient, derived from the aperture admittance, are compared with both the experimental and theoretical results of a similar problem which is solved by application of the geometrical theory of diffraction. Finally, for various aperture widths, a Smith chart is employed to show that as the distance between the aperture and the reflecting sheet is increased, the admittance locus tends to coalesce about the admittance value for an infinite half-space. Author

N68-18178*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PERFORMANCE OF SEVERAL CONVOLUTIONAL AND BLOCK CODES WITH THRESHOLD DECODING
Frank Neuman and Dale R. Lumb Washington Mar. 1968 74 p refs
(NASA-TN-D-4402) CFSTI: HC $3.00/MF $0.65 CSCL 09D

The performance of several codes applicable to space communications telemetry links was evaluated. The study was limited to high rate and relatively short constraint length codes, specifically the (15,7) and (73,45) block codes and the (24,12) and (44,22) convolutional codes. Two types of threshold decoding schemes were applied, namely, majority decoding and the more powerful but complex a posteriori probability (APP) decoding. The gaussian data channel and the decoders were simulated on a general purpose computer. The results show that APP decoding has approximately a 1.5 dB advantage over majority decoding. The most powerful code studied, (73,45) with APP decoding, gives a 2.1 dB improvement over a seventh bit parity check code. Also, new error deletion schemes were designed and tested for the codes studied. Because of their constant computation rate, these codes are candidates for high data rate channels. For the low data rates required for deep space missions such as Pioneer, however, the code performances reported here form a basis of comparison with the more powerful sequential decoding of convolutional codes, a variable computation rate decoding technique. Author

N68-18181*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PORTABLE AUTOMATIC CALIBRATION TRACKER Progress Report
Walter J. Carrion Jan. 1968 10 p
(NASA-TM-X-63116; X-524-68-1) CFSTI: HC $3.00/MF $0.65 CSCL 17I

The Portable Automatic Calibration Tracker (PACT) was developed to improve the angular calibration of antennas and radio satellite tracking systems in NASA's Satellite Tracking and Data Acquisition Network. PACT is a significant advance in the state-of-the-art of real time tracking and data presentation. It has an absolute pointing accuracy of 7 seconds of arc, and can autotrack a celestial target to an accuracy better than 3 seconds of arc. An error model was developed, evaluated, and applied to the data for precision tracking instruments. PACT's main deficiencies are in its ability to track the calibration aircraft during daylight hours and the time consuming alignment procedures for aligning PACT to the station coordinates. Cooling the detector does not appear to give a sufficient gain to achieve full daylight capability. A laser retroreflector, discarded in the earlier phases of the development program because of safety and reliability, should be reconsidered. Presently, the system's station alignment procedures are being improved and it is being temperature cycled to determine physical changes or damage that may occur from environment. R.N.A.

N68-18199*# California Univ., Berkeley. School of Forestry.
A TEST OF THE CONCEPT AND PRACTICAL APPLICATION OF MULTIBAND RECONNAISSANCE Final Report
Robert N. Colwell and Jerry D. Lent 30 Sep. 1967 89 p refs
(Grant NGR-05-003-080)
(NASA-CR-93365) CFSTI: HC $3.00/MF $0.65 CSCL 17B

The potential advantages, limitations, and means of optimizing multiband reconnaissance techniques for earth-resource inventories are explained. Use is made of artificial and natural arrays to illustrate the concepts of tone signature analysis and color additive image enhancement, and a means is given for determining from a number of film–filter combinations, which ones are the best for a two-band reconnaissance system, and for progressively larger numbers of bands, up to and including six. In order to understand how multiband reconnaissance can give useful information about earth's natural resources, the basic matter and energy relationships are assessed along with photographic relationships in terms of energy levels, and target tone signature analysis. The problems of the multiband technique discussed include natural terrain features that tend to be more complex than artificial target arrays, optimum wavelength bands for use in achieving various objectives, obtaining the required spatial resolution on multiband imagery, and problems occasioned by limitations of the image analyst. B.S.D.

N68-18247*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THEORETICAL AND PRACTICAL RESOLUTION LIMITS FOR PROCESSING PULSE FREQUENCY MODULATION TELEMETRY
Thomas J. Karras and Paul Heffner Washington Mar. 1968 29 p refs
(NASA-TN-D-4180) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The importance of knowing the meaning, methods of computation, and proper use of the equivalent noise bandwidth (ENBW) of a system is presented. From this, a normalized relation for expressing the signal energy per bit of information and the noise power density of the noise in the signal will be developed and compared to the most common S_{rms}/N_{rms} measurement. A universal Pulse Frequency Modulation (PFM) telemetry data processing line incorporates two processing subsystems, a low resolution processor and a high resolution processor. The low resolution processor resolves the data measurement to 1 percent of the data spectrum, while the high resolution processor resolves the data measurement within 0.02 percent to 1 percent. The resolution given by the high resolution processor is a direct function of the input signal-to-noise ratio. The theoretical and actual performance of both modes of processing are described. Reference is made to three presently transmitting PFM satellites. Author

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N68-17257# Atomics International, Canoga Park, Calif.
EDIT—A FORTRAN 4 LEVEL H PROGRAM TO PUNCH, PRINT, AND PLOT SELECTED PORTIONS OF AN ENDF/B DATA TAPE
R. S. Hubner and B. J. Lemke 1 Nov. 1967 103 p ref
(Contract AT(04-3)-701)
(NAA-SR-12525; ENDF-105) CFSTI: HC $3.00/MF $0.65

The EDIT program was written in FORTRAN IV Level H for the IBM System 360 Model 50 (S/360-50) computer. It will process selected materials and files on an ENDF/B EBCDIC data tape. Punching as well as printing may be requested for all seven files. Plotting with SC-4020 equipment may be requested for File 1 (first two sections) and Files 3 through 6. EDIT input and output are described. Examples of EDIT's use are given. Author (NSA)

N68-17258# Illinois Univ., Urbana. Dept. of Computer Science.
COMMUNICATION NET OF MODULAR PROCESSORS FOR A MULTIPROCESSOR COMPUTER
Shiu Kwong Chan (M.S. Thesis) 1 Jun. 1967 45 p refs
(Contract AT(11-1)-1018)
(COO-1018-1116; Rept.-231) CFSTI: HC $3.00/MF $0.65

A communication net of modular processors for the multi-processor computer Illiac III is modeled in this paper. The model contains design features which allow the computer to operate with a variable number of modules, allow modules within a group to use alternate terminals so that when one terminal fails to function properly the module can be reattached to another one, and eliminate the hazard of the parallel access of the same module by two others where this is not allowed. All the requirements imposed on the communication net by the surrounding units are met, and an appropriate interface convention has been established. Author (NSA)

N68-17283# American Mathematical Society, Providence, R. I.
DEVELOPMENT OF COMPUTER AIDS FOR TAPE CONTROL OF PHOTOCOMPOSING MACHINES. REPORT NO. 1: MECHANIZATION OF MATHEMATICAL REVIEWS OFFICE PROCEDURES
Mar. 1967 47 p refs
(Grant NSF GN-533)
(PB-176192) CFSTI: HC $3.00/MF $0.65

A systems design for the automation of Mathematical Reviews office procedures. These programs fall into three general classes: recognition of typewritten input and construction of the master file; manipulation of the master file; preparation of master file information for service bureau processing. Author

N68-17287*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DIGITAL FILTER SYNTHESIS PROGRAM
Robert M. Munoz and Richard A. Moyer 25 Sep. 1967 46 p refs
(NASA-TM-X-62000) CFSTI: HC $3.00/MF $0.65 CSCL 09B

In order to perform computations on the differential equations of continuous time varying quantities using the general purpose digital computer, it is necessary to form the difference equations or computational alogorithms that approximate the differential equations. To do this, the "Digital Filter Synthesis Program" was written. This program written in Fortran IV uses the bilinear transform method to approximate linear differential equations with constant coefficients. It allows inputs to be presented as functions of "s" (complex frequency) in either the factored or unfactored form and it presents the coefficients of the difference equations as intermediate outputs. The program tabulates input and output data lists representing the discrete form of time varying input and output quantities for the transfer functions represented by the differential equations. A subroutine for graphical display of the outputs by use of the print plot technique is also included in the program. Author

N68-17322# Illinois Univ., Urbana. Dept. of Computer Science.
ATTACHMENT 2: ARTRIX Final Report
J. W. Esch, A. F. Irwin, W. J. Kubitz, P. E. Oberbeck, W. J. Poppelbaum, et al. 24 May 1967 219 p
(Contract AT(11-1)-1469)
(COO-1469-0067) CFSTI: HC $3.00/MF $0.65

The design and performance of the graphical processing system ARTRIX are presented. ARTRIX is a self-contained processing system employing both analog and digital circuitry. Digital outputs are easily provided, thus enabling ARTRIX to be used on-line with a computer. NSA

N68-17554*# Nuclear Utility Services, Inc., Washington, D. C.
DESCRIPTION OF DRAW: A CODE TO CALCOMP PLOT GAMMA PHOTON SPECTRA
Y. S. Kim Sep. 1967 37 p refs
(Contract NAS5-10337)
(NASA-CR-93211; NUS-397) CFSTI: HC $3.00/MF $0.65 CSCL 09B

A FORTRAN IV code for the IBM-7094 digital computer has been developed to CALCOMP plot histogram distributions. The code, specifically designed for multi-channel pulse-height analyzer spectra and calculated photon number and energy spectra, labels the Cartesian axes according to various options. It titles each plotted figure according to the user's input. Author

N68-17783# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering.
A CANONIC TRANSLATOR
Joseph Wright Alsop Nov. 1967 86 p refs
(Contract Nonr-4102(01))
(MAC-TR-46; AD-663503) CFSTI: HC $3.00/MF $0.65

The thesis presents an algorithm to recognize and translate sets of character strings specified by canonic systems. The ability of canonic systems to define the context sensitive features of strings and to specify their translation allows the algorithm to

recognize and translate real computer languages. It is also applicable in other language systems. Canonic systems are discussed, and several examples of their use are given. The algorithm is described, and examples of canonic translation are presented using a program implementation. Author (TAB)

N68-17915# Lincoln Lab., Mass. Inst. of Tech., Lexington.
GRAPHICS Semiannual Technical Summary, 1 Jun.–30 Nov. 1967
Jack I. Raffel 30 Nov. 1967 34 p refs
(Contract AF 19(628)-5167; ARPA Order 691)
(ESD-TR-67-570; AD-663728)

The APEX display executive has been in regular operation and experience with new display hardware and a remote display console has been helpful in pinpointing needed changes. The APEX interrupt executive has been completed and will be evaluated during the next quarter. A new APEX scheduling algorithm has been implemented in order to improve the system response to users. The 338 remote console is operational in Washington, D. C., and is being used on a routine basis. The compiler-compiler system VITAL is in regular use. The programming language LEAP, implemented using VITAL, has been used for programming constraint problems, a portion of the new VITAL system, integrated circuit mask layout, and two debugging packages. These latter present their data graphically to the user. The design of an improved VITAL system is under way. The earth display program created earlier in the year has been used on actual data obtained from LES-4. A new approach for solving constrained systems is under development which uses a geometrical model. Several trial applications of this method have been programmed using LEAP. A special compiler and language for testing integrated circuits have been developed. A theory of generalized superposition has been applied to waveform processing. Programs have been developed for scanning, processing, and photographing pictures which are subjected to this new kind of filtering. Programs for integrated circuit mask layout are under development which will allow designers to sketch in mask components and rearrange them in search for a satisfactory layout. Photographs can then be taken of the resulting masks. Author (TAB)

N68-17954# Washington Univ., Seattle. Dept. of Electrical Engineering.
AN ADAPTIVE TREE PRUNING SYSTEM: A LANGUAGE FOR PROGRAMMING HEURISTIC TREE SEARCHES Interim Scientific Report
Edward W. Kozdrowicki Aug. 1967 272 p refs
(Grant AF-AFOSR-939-67)
(AFOSR-68-0038; AD-663750)

The development of a tree pruning system (TPS) consisting of a set of system statements to be used as instructions for programming of heuristic tree searches. The system is imbedded in FORTRAN, designed to treat non-uniform tree structures. Search decisions are automatic, either on the basis of user overall specification or machine-learned criteria. The basic application leading to the development of the TPS is chess. System value is demonstrated by successful and simple duplication of the Baylor and Simon Chess Mating Combination Program. . . . Author (TAB)

N68-18038# Washington Univ., Seattle. Dept. of Electrical Engineering.
A PATTERN RECOGNITION MODEL FOR ON-LINE CURVE FITTING: AN APPLICATION OF THRESHOLD THEORY Interim Scientific Report
Gordon H. Syms Aug. 1967 209 p refs
(Grant AF-AFOSR-939-67)
(AFOSR-68-0037; AD-663431)

The report describes the development of an adaptive pattern classifier in application to curve fitting problems. The research develops additional theory for general pattern classifiers; i.e., one-step correction under various training methods, and development of a modified Euclidean metric. Two adaptive pattern classifiers have been designed for solutions of practical scientific problems. Heuristics for learning are coupled to threshold logical theory. In application the curve fitting model classifies realistic patterns at 200 to 300 patterns per minute on the Burroughs B5500 with average error of 3.5%. The method does not require the good initial curve coefficient guesses required by other approaches. TAB

N68-18049# Decision Science, Inc., San Diego, Calif.
EVOLUTION OF FINITE AUTOMATA FOR PREDICTION Final Report, 16 May 1966–16 Aug. 1967
Michael J. Walsh Griffiss AFB, N. Y. RADC Nov. 1967 69 p refs
(Contract AF 30(602)-4296)
(RADC-TR-67-555; AD-663765)

This is the final report of the mathematical investigation conducted under Contract No. AF30(602)-4296 to determine classes of environments which are amenable to representation by finite-state functions, to classify the corresponding finite-state functions and to study the structure of finite-state machines which generate these functions. The results form the basis for improvement of the algorithms for evolving finite-state machines capable of predicting an environment or of representing a transformation between environments with respect to a given goal. Author (TAB)

N68-18051# Washington Univ., Seattle. Dept. of Electrical Engineering.
AN ADAPTIVE COMPUTING SYSTEM FOR THE SYNTHESIS OF THRESHOLD LOGIC NETWORKS
Thomas Anthony Marsland Aug. 1967 155 p refs
(Grants AF-AFOSR-939-67; NSF GK-680)
(AFOSR-68-0039; AD-663446)

The report describes development of an adaptive program to examine real problems with unknown solutions; improving performance on the basis of system experience. A new scheme, reflecting Boolean functions on a Veitch diagram, is developed for classification of Boolean functions. A theorem is presented for the calculation of Rademacher-Walsh coefficients of self-dual functions. A heuristic training algorithm is developed which evolves a minimal element threshold logic net. The value of making exploratory studies through a learning interactive program are illustrated and discussed. TAB

N68-18062*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 16: ELEMENTS OF COMPUTERS
Robert L. Miller Washington 1968 14 p Presented to Lewis Aerospace Explorers, Cleveland, 1966–1967
(NASA-TM-X-52403) CFSTI: HC $3.00/MF $0.65 CSCL 09B

The comparative advantages and disadvantages of electronic analog and digital computers are discussed with respect to the study of rocket performance. The analog computer, operating in real time, can provide immediate continuous plots of computed results. Accuracy is about 99% on the average, and about 10 variables can be handled simultaneously. The digital computer, on the other hand, generally does not operate in real time. It can perform more complex calculations than the analog though, and has the advantage of a stored program for increased flexibility. The number of variables which can be processed is unlimited, and their accuracy is limited only by the number of bits representing the variable. The simple, sequential programming steps required by either type of electronic computer are briefly described, as is the required peripheral equipment. E.J.S.

N68-18144*# Avco Corp., Wilmington, Mass.
INVESTIGATION OF THE DYNAMIC CHARACTERISTICS OF A V ANTENNA FOR THE RAE SATELLITE, PHASE A Final Report
Washington NASA Mar. 1968 211 p refs
(Contract NAS5-9179)
(NASA-CR-962; RAD-TR-65-28) CFSTI: HC $3.00/MF $0.65 CSCL 09F

This report presents the results of the first phase of an investigation of the dynamic characteristics of the Radio Astronomy Explorer satellite equipped with a double-V antenna. During this first phase, computer programs which will provide the analytical tools necessary for continued study of the satellite dynamic performance have been prepared. For this purpose, a flexible-body analog computer program, a rigid-body digital computer program, and a flexible-body digital computer program were developed. The first two programs have been checked out and are fully described and included in this report, together with results of checkout runs. The flexible-body computer program is being checked out; the detailed derivation and description of the simulation is contained in this report. It is recommended that the next phase of the study provide for improvement in the accuracy and capability of the computer simulations and evaluation of satellite and control system dynamics, damping requirements, and overall satellite design. Author

N68-18179*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A LOGARITHMIC ENCODER FOR BINARY WORD COMPRESSION
Joseph A. Sciulli Washington Mar. 1968 12 p refs
(NASA-TN-D-4290) CFSTI: HC $3.00/MF $0.65 CSCL 09D

The present paper describes a logarithmic encoding device which has had particular application in energetic particle detection experiments. The paper provides a generalized encoding error analysis in order to evaluate the performance of the device. Both peak and average error are derived in terms of word size and desired accuracy. The implementation of a flexible logarithmic encoder is also described. Author

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N68-17224# Sandia Corp., Albuquerque, N. Mex.
FERROELECTRIC CERAMIC ELECTROOPTIC STORAGE AND DISPLAY DEVICES
C. E. Land Oct. 1967 51 p refs Presented at the Intern. Electron Devices Meeting, Washington, D. C.
(Contract AT(29-1)-789)
(SC-R-67-1219; CONF-671037-1) CFSTI: HC $3.00/MF $0.65

Certain newly developed, hot-pressed ferroelectric ceramics offer an apparently practical solution to the design of extremely high-density, optically interrogated, information storage devices. In addition to optical memory applications, the materials appear to be equally useful in high resolution, controlled-persistence displays, and in both electrooptic and acoustooptic modulation and deflection devices. The potential uses of these materials in a wide variety of optical devices and systems are made possible by their unique, electrically variable optical properties. Some of the optical and switching properties of hot-pressed lead zirconate-lead titanate (PZT) ceramics are described. A number of proposed optical devices are discussed, including a medium density memory which is in the research prototype stage of development. Author (NSA)

N68-17620*# Watkins-Johnson Co., Palo Alto, Calif.
TWENTY-WATT HIGH IMPACT TRAVELING-WAVE TUBE AMPLIFIER Final Report
Edward R. Dornseif 9 Feb. 1968 192 p Prepared for JPL
(Contracts NAS7-100; JPL-951287)
(NASA-CR-93192) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The design and development of a traveling wave tube amplifier (TWTA) for space communications applications are described. The TWTA, which is for operation during and after higher impact shocks to levels of 10,000 G for 1 millisecond duration, consists of a traveling wave tube (TWT) and a band reject and harmonic filter. The performance, physical configurations, materials, and TWT design parameters are delineated along with details on filter configuration and design aspects. The evaluation, initial design, and approach of TWT development are discussed in relation to cathode support, electron gun, helix, RF windows and strip line, ceramics, and the effect of shock waves on the magnets. Consideration is also given to the temperature sterilization and electrical design of the TWT, and an investigation was conducted on the magnetic leakage field and cathode temperature. The TWT reliability and life are discussed with respect to design, construction, and quality assurance testing. The effects of barium on cathode life are analyzed. B.S.D.

N68-17627# National Bureau of Standards, Washington, D. C.
SECOND BREAKDOWN IN SEMICONDUCTOR DEVICES Bibliography
Harry A. Schafft Oct. 1967 44 p refs
(NBS-TN-431) GPO: HC $0.30; CFSTI: MF $0.65

Almost 200 references with appropriate key words are listed which provide, it is believed, a comprehensive coverage of the literature of second breakdown in transistors and other semiconductor devices from 1958 through much of 1967. A representative list of earlier papers dealing with what appears to be second breakdown in point-contact and p-n junction diodes is also included. The indexes consist of an author index and an index to subject matter with reference tabulations and with key word assignments. Author

N68-17700*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
APOLLO CSM AND LM ELECTRICAL INSPECTION CRITERIA
1 Dec. 1967 209 p
(NASA-TM-X-60876; RA064-001-1A) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Uniform electrical acceptance and rejection criteria are established for the electrical fabrication and installation in the Apollo Command Service Module and Lunar Module. These criteria are specified for the following categories: (1) wire bundle fabrication and routing, (2) support and clamping of wire, (3) mechanical and soldered terminal connections, (4) printed circuit and terminal board assemblies, (5) splices and shield terminations, (6) chafing and clearances, (7) potting, molding, and conformal coating, (8) connectors and safety wiring, (9) stowage, (10) tool and equipment control, (11) identification, and (12) cleanliness. Training program and documentation requirements are also specified; and all of the criteria and requirements are applicable to all NASA organizations, government agencies, and contractors participating in contracts for Apollo flight hardware. M.W.R.

N68-17831*# Stanford Research Inst., Menlo Park, Calif.
ANALYTICAL AND DEVELOPMENTAL INVESTIGATION OF ELECTRON STRIP MULTIPLIERS, PHASE 3 Final Report
Donald R. Cone Dec. 1967 46 p refs
(Contract NAS5-9396; SRI Proj. 6281)
(NASA-CR-93246) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The effort encompassed the study of gain changes in electron multipliers as a function of their operational parameters and their

environment, especially temperature, pressure, and residual-gas constituents. The basic environment was a room-temperature, vac-ion-pumped, ultra-high-vacuum (UHV) station operated at pressures below 10^{-8} torr. Temperature excursions were from about 0°C to 70°C. The pressure was varied from 10^{-9} torr to about 10^{-4} torr. In addition to the normal vac-ion residual-gas environment, partial pressures of nitrogen, oxygen, argon, carbon dioxide, hydrogen, and air were introduced for varying time periods. Commercial and experimental continuous-dynode multipliers and a discrete-dynode multiplier, all with radioactive β source inputs, were operated simultaneously in close proximity to each other within the common vacuum environment, with comparable initial output currents. The gain change was measured and evaluated as a function of operating time and other parameters over a period of eight months of essentially continuous operation. Postoperational electrical, optical, physical, and chemical analyses of the multipliers and collector electrodes were conducted. Author

N68-17833# Texas Univ., Austin. Defense Research Lab.
LOW FREQUENCY SUB-AUDIO TRIPLEXER
Herbert Andrew Hamblin 2 Jan. 1968 69 p refs
(Contract N60921-7233)
(DRL-TR-68-2; AD-663708)

A low frequency sub-audio triplexer was designed and built for use with a thermal writing paper oscillograph machine. The purpose of the triplexer is to enable one channel of a recording system to record three different input signals; this is accomplished by electronically switching the output circuit to each of three input circuits, one at a time. Each input base line can be controlled as can the time duration during which a given input is sampled. Also, a coding signal is provided for positive identification of each signal. The one output circuit and the three input circuits are balanced with respect to ground; with both sides floating, the input signals can be triplexed. The frequency response of this circuit is from dc to 3 dB down at 360 kHz with better than 60 dB of isolation (measured at 15 Hz) between the various input circuits. Also, a 5 M ohms ladder attenuator is provided on each input so that large signals may be triplexed. The circuit input impedance is 5 M ohms and the output impedance is about 100 ohms. The dynamic range is approximately 92 dB with the maximum allowable input signal equal to 11.5 V peak-to-peak. Author (TAB)

N68-17837# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
IMPROVED 49-GHZ GALLIUM-ARSENIDE MIXER DIODES WITH GOLD-COPPER ALLOY WHISKERS
M. McColl, M. F. Millea, and J. Munushian Oct. 1967 13 p refs
(Contract F04695-67-C-0158)
(TR-0158(3230-13)-2; SAMSO-TR-67-124; AD-663719)

Reduced conversion loss and improved yield and reliability have been obtained in 94-GHz gallium-arsenide mixer diodes by the substitution of a gold-copper alloy wire for the conventional phosphor bronze whisker. Author (TAB)

N68-17881# European Atomic Energy Community, Ispra (Italy).
LOW NOISE PULSE AMPLIFIER FOR Ge(Li) DETECTORS
R. Benoit, L. Isabella, and V. Mandl Dec. 1967 30 p refs
(EUR-3659.E) CFSTI: HC $3.00/MF $0.65

A low noise FET input amplifier with a threshold post amplifier has been built. The nominal gain of the amplifier is 1000 and the output range ± 10 V; the post amplifier has a variable threshold from 0 to 10 V, a gain of 10 and a maximum output of + 10 V. The amplifier was used to study the performances of RLC filters and an improvement in energy resolution of 13% over the conventional RC clipping network has been obtained. Author

N68-17934# Ion Physics Corp., Burlington, Mass.
ION IMPLANTED MOS DEVICE Final Report
F. Leith, C. Guild, and W. J. King Griffiss AFB, N. Y. RADC Dec. 1967 30 p refs
(Contract AF 30(602)-4177)
(RADC-TR-67-478; AD-663737)

The final report is made on the fabrication of MOS transistors by ion implantation. Two different n-channel depletion mode MOS transistors were fabricated. These transistors are to be used to compare surface states of the ion implanted units with surface states of conventional diffused devices. Author (TAB)

N68-18008# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TRAVELING-WAVE TUBE
M. B. Tseytlin and A. M. Kats 9 Jun. 1967 239 p refs
Transl. into ENGLISH of the book "Lampa s Begushchey Volnoy" USSR, Izd. Sov. Radio, 1964 p. 1–311
(FTD-MT-65-453; AD-663875)

In monograph is expounded theory of traveling-wave tube. Basic attention is allotted to question of interaction of electron stream with traveling wave for large values of amplification factor in application to tubes of medium and high power. In detail is investigated influence of local absorber and reflections from matching devices on characteristics of TW tube (JIBB). Analysis is conducted of work of TW tube during finite levels of input signal. On the basis presented theory method of calculation of basic parameters of TW tube of helical type is offered. Monograph is designed for engineers and scientists working in field of shf electronics and also for teachers and students of higher educational institutions. Author (TAB)

N68-18022*# General Precision, Inc., Little Falls, N. J. Materials Dept.
THERMOCHROMIC DISPLAY MATERIALS FOR USE UNDER WIDE VARIATIONS IN AMBIENT ILLUMINATION LEVELS Annual Progress Report
31 Jan. 1968 67 p refs
(Contract NAS12-89)
(NASA-CR-86031; APR-2) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Consideration is given to the development of useful thermochromic materials and their applications in display devices. Emphasis was placed on the synthesis and evaluation of ternary halides and chalcogenides, these being inorganic crystals which exhibit pronounced and reversible color changes with change in temperature. Each material can exist in either of two distinct thermodynamic states depending on the temperature. The color change occurs at a sharp transition temperature and is accompanied by a dramatic change in electrical conductivity and by discontinuities in heat capacity. Efforts have concentrated on the utilization of thermochromic materials either by themselves or in combination with standard phosphors as screen materials in cathode ray tubes (CRT's). The ability of an electron beam to induce thermochromic transitions in a demountable CRT system is demonstrated. Some mixtures of thermochromic materials and conventional CRT phosphors appear to be compatible and demonstrate both thermochromic and luminescent properties under electron bombardment. Author

N68-18170# Naval Research Lab., Washington, D. C.
A WAVEGUIDE RECIPROCAL DIGITAL FERRITE PHASE SHIFTER Interim Report
W. H. Mendenhall, Jr. and M. F. Becker Nov. 1967 22 p refs
(NRL-MR-1836; AD-663561)

A survey-type study of the propagation characteristics of a reciprocal latching ferrite-loaded waveguide phase shifter configuration was made at X-band. Both single bit and multibit

models were investigated with respect to dielectric loading and bit interaction. Performance data relative to a three-bit model constructed at X-band with a 300 MHz bandwidth is presented. Author (TAB)

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N68-17421# Cambridge Univ. (England). Dept. of Engineering.
ELEMENTS OF CONTROL THEORY
J. Billingsley *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 203–222 refs (See N68-17413 08-31)

First a control system is defined and the notion of 'state' introduced. The use of the phase-plane in second-order systems is then explained and some examples given. For systems of order greater than two, a direct method involving representation in a phase-space may be used; this is known as Liapunov's second method. A technique is then described for analysing any linear system by matrix representation and determination of the normal modes. Then the optimal control is dealt with. After a brief mention of optimized linear control, the technique of optimal control by means of Pontryagin's principle is described and illustrated by an example. Finally, a brief survey is given of predictive control. Author (ESRO)

N68-17433# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).
THE INVERSION OF THE CONVOLUTION PRODUCT IN PHYSICS. (SURVEY TO THIS DAY) [L'INVERSION DU PRODUIT DE CONVOLUTION EN PHYSIQUE. (MISE AU POINT BIBLIOGRAPHIQUE)]
Andre Girard 1967 13 p refs In FRENCH; ENGLISH summary (ONERA-NT-121)

Most of the information circuits used in physics may be considered as limited-spectrum linear filters. Many authors studied to what extent it is possible to know an input signal when the output function and the impulse response of the linear filter are known. The inevitable noise of the output signal practically suppresses the bi-univocal character of the convolution relation linking these three factors. However various numerical methods can be used to improve knowledge on the input function in the frequency domain supporting the linear system. Theoretically it is possible to extend such knowledge beyond this domain. Author

N68-17570# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CYBERNETICS IN THE NAVY
A. L. Lifshits 12 May 1967 231 p refs Transl. into ENGLISH of the book "Kibernetika v Voyenno-Morskom Flote" Moscow, Voyennoye Izd. Min. Oborony SSSR, 1964 p 1–258
(FTD-MT-65-80; AD-663927) CFSTI: HC $3.00/MF $0.65

The book acquaints the readers with the general fundamentals of cybernetics and the basic ideas of the application of its methods for military purposes. The reader will become familiar with the military applications of information theory, the principles of the development of algorithms and machine solution of operational-tactical problems, and also the basic methods of operations research. The book also considers questions of the automation of force control and the use of cybernetic methods for instructing and training personnel in the control of weapons, equipment, ships, and ship squadrons. The book is intended for a broad group of naval officers and other members of the armed forces, teachers, students and cadets of military and naval academies, and workers of the shipbuilding industry. It also is of interest to students and teachers of higher educational institutions and to engineers that are working in the various areas of controlling the processes of industrial objects. Author (TAB)

N68-17611*# Scripta Technica, Inc., Washington, D. C.
NEW METHOD FOR DETERMINING THE CHARACTERISTICS OF COMPLEX DYNAMIC SYSTEMS [NOVYY METOD OPREDELENIYA KHARAKTERISTIK SLOZHNYKH DINAMICHESKIKH SISTEM]
L. I. Voronova and Yu. V. Krementulo Washington NASA Feb. 1968 18 p refs Transl. into ENGLISH from Naukova Dumka (Kiev), 1966 p 82–101
(Contract NASw-1694)
(NASA-TT-F-11220) CFSTI: HC $3.00/MF $0.65 CSCL 09C

Description of a new method involving multiple integration within a moving interval for determining the order of a differential equation for a linear dynamic system together with numerical values for the coefficients. It is demonstrated that additive noise having an average value of zero within the interval of integration does not cause errors in the determined coefficients. Author

N68-17653*# Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center.
LAUNCH AND SPACE VEHICLE CONTROL STUDIES. VOLUME 1: DIGITIZED NON-LINEAR FILTER FOR LAUNCH VEHICLE APPLICATION Final Report
22 Sep. 1967 117 p refs
(Contract NAS8-21034)
(NASA-CR-61549; LMSC/HREC-A784590-I, V. 1; HREC-1034-1, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A digital implementation of a nonlinear signal filtering concept is presented. Difference equations are derived to perform the same signal splitting and phase shifting functions as the linear networks in the analog configuration. The development of the digital logic and the methods used to obtain the difference equations are discussed. This method is based on comparing the classical results of linear differential and difference equations, and on making the transition from differential equation to difference equation. Details are also given on the simulation and application of the nonlinear filter in the Saturn 5 attitude control system for the AS-503, S-IC boost phase. System simulation is completely digital and includes the first three vehicle bending modes in addition to propellant sloshing models for the first three tanks. Two forms of the filter are investigated: a continuous version which represents an active, electrical network realization, and a corresponding digital version for realization in the onboard digital computer. Results indicate the feasibility of using the nonlinear filter in both the analog version and the digital implementation. M.G.J.

N68-17737*# General Dynamics/Convair, Huntsville, Ala.
A STUDY OF MINIMAX SOLUTIONS FOR SATURN CONTROL PROBLEMS Final Report
C. D. Johnson May 1967 78 p refs
(Contract NAS8-18008)
(NASA-CR-61579; GD/C-DDF-67-003) CFSTI: HC $3.00/MF $0.65 CSCL 09C

The possibility of using a theory previously developed for a certain class of minimax control problems for designing an automatic machine solution technique is explored in more detail, and a concrete algorithm is developed. A hybrid-analog computer realization of the algorithm is proposed and an application of the algorithm, to a certain load-minimizing control problem for the Saturn launch vehicle is described. The problem of incorporating explicit state variable inequality constraints in the solution of Chebyshev minimax control problems is also discussed and several alternative methods are proposed. The problem of accommodating constant unmeasurable system disturbance inputs in the solution of the linear optimal regulator problem was considered. A mathematical theory for this class of problems was developed and results are presented. Author

N68-17772# Illinois Univ., Urbana. Coordinated Science Lab.
BOUNDED INPUT–BOUNDED OUTPUT STABILITY OF NONLINEAR TIME-VARYING RC NETWORKS
T. N. Trick Nov. 1967 18 p refs
(Contract DAAB07-67-C-0199; Grant AF-AFOSR-931-67)
(R-369; AD-663807)

It is shown that if a nonlinear time-varying capacitor, whose incremental elastance is finite and greater than zero for all time, is embedded into a lumped linear passive time-invariant RC network, then the network is always bounded input-bounded output stable. In fact, if the input is periodic with period T, then the transient response asymptotically approaches a unique bounded periodic response with period T. Author (TAB)

N68-17933# Boeing Scientific Research Labs., Seattle, Wash. Information Sciences Lab.
APPROXIMATION TO THE TIME-OPTIMAL CONTROL OF LINEAR STATE-CONSTRAINED SYSTEMS
A. Frederick Fath Oct. 1967 30 p refs
(D1-82-0675; Rept.-6; AD-663643)

A procedure is presented for approximating the time-optimal control for linear state-constrained systems. The constraint sets on both the state variable and the control vector can be any sets able to be approximated by piecewise-constant convex polygonal sets. The target set can be specified as any convex polygonal set about the origin in state space. The approximation is obtained by reformulating the problem such that iteration on a scalar quantity (the final time) is needed with a linear programming problem solved at each iteration. An example using a fourth order system is presented. Author (TAB)

N68-17944# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
A DUALITY THEORY FOR ABSTRACT MATHEMATICAL PROGRAMS WITH APPLICATIONS TO OPTIMAL CONTROL THEORY
Richard M. Van Slyke (Calif. Univ., Berkeley), and Roger J.-B. Wets Oct. 1967 52 p refs Sponsored in part by NSF Prepared in cooperation with Calif. Univ., Berkeley *Its* Mathematical Note No. 538
(D1-82-0671; AD-663661)

The paper gives necessary and sufficient conditions for optimality for convex programs in abstract spaces. The results obtained here contain as special cases all known duality theorems for convex mathematical programs as well as the results on optimality for linear problems in the calculus of variations and optimal control theory. The geometric aspect of the theory has been given particular emphasis. Author (TAB)

N68-18031# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AN APPROACH TO SYSTEMS WITH A GAUSSIAN PARAMETRIC COEFFICIENT
Carroll N. Day (Ph.D. Thesis—Ohio State Univ.) 1967 87 p refs
(AFIT-TR-67-14; AD-663758)

The object of the research reported in this dissertation was to study systems with a Gaussian parametric coefficient using a nonharmonic series to represent the random coefficient. The series used to represent the random variable is constructed of uncorrelated terms. A series also with uncorrelated terms, is found to represent the system output variable. A method is developed to evaluate the terms of this output series as a function of the power density spectrum of the parametric coefficient and other system parameters. Having found the terms of this series the moments and other statistical measures of the output variable can be calculated. Thus the dissertation details an algorithm which can be used to calculate the output statistical measures for a class of systems containing Gaussian parametric coefficient. The mean and auto-correlation function of the output and the cross-correlation between the input and output are calculated for two examples to demonstrate the algorithm. No attempt was made to find theoretical error bounds on calculations based on the algorithm. However, examples included in the dissertation indicate that the error is small. Author (TAB)

N68-18202# Massachusetts Inst. of Tech., Cambridge.
ON THE SIMULATION OF DYNAMIC SYSTEMS WITH LUMPED PARAMETERS AND TIME DELAYS
Nestor Leal-Cantu (M.S. Thesis) Oct. 1967 105 p refs
(Contract Nonr-4102(01))
(MAC-TR-45; AD-663502)

The thesis develops a method for digital simulation of linear time-invariant dynamic systems with lumped parameters and time delays. Ordinarily, such systems can be described by a linear matrix differential-difference equation, which can be transformed to an infinite-dimensional difference equation whose solution is obtained in a recursive way. As the present method depends on the accuracy of evaluation of the matrix exponential, a simple computational procedure based on the truncation of the infinite series for e to the power (AT) is described. In addition, an algorithm is given which ensures that the transient state of an unforced linear time-invariant dynamic system with zero time delay is calculated to a specified accuracy. Several sample problems are included. Author (TAB)

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N68-17220# Sandia Corp., Livermore, Calif.
DEVELOPMENT OF A TECHNIQUE FOR TESTING WITH HEAVY GASES IN EXPLOSIVE-DRIVEN SHOCK TUBES
A. F. Emery (Washington Univ., Seattle) and W. T. Ashurst Nov. 1967 58 p
(Contract AT(29-1)-789)
(SCL-DR-67-49) CFSTI: HC $3.00/MF $0.65

The development of the Thunderpipe technique for shock tube testing with heavy gases is developed. The feasibility of testing with octofluorocyclobutane (C_4F_8) and sulfur hexafluoride (SF_6) was indicated by an initial series of tests in a small laboratory shock tube. Subsequent production tests in larger shock tubes, however, revealed the presence of random pressure variations in the preferred gas, C_4F_8. A further investigation of the properties of C_4F_8 was therefore carried out. Examination of shock front photographs and analytical studies showed that the irregularities were caused by decomposition of the gas behind the shock. The use of a nitrogen buffer between the explosive and the C_4F_8 was found to alleviate the problem only slightly. Photographs of shock fronts in SF_6 showed no decomposition, and although pressure irregularities in production testing were observed, their distribution was not random. Analytical studies using numerical computations have shown these irregularities to be the result of oscillating flow fields formed by asymmetrical charge distributions and perturbations caused by an impedance mismatch at the contact surface. Author (NSA)

N68-17274# Royal Aircraft Establishment, Farnborough (England).
AIRCRAFT STRUCTURAL TEST FACILITIES IN THE U.K.
R. C. Pickering and P. Talbot Apr. 1966 60 p ref
(RAE-TR-66116)

This report outlines the fundamentals of the structural testing at room temperature of major aircraft specimens and illustrates their application at testing installations in the U.K. A survey of these facilities covers methods of application, control and measurement of load, together with other relevant information, for example, the recording of test results. The aim of this survey was to determine the relative popularity of various ideas and techniques, and to show the trend which test methods are following. Author

N68-17301# Sandia Corp., Albuquerque, N. Mex.
A DIGITAL PITCHING SECTOR CONTROL SYSTEM FOR THE SANDIA 18-INCH HYPERSONIC WIND TUNNEL
Donald R. Mac Kenzie Oct. 1967 9 p Presented at the 28th Supersonic Tunnel Assoc. Meeting, Denver, 30 Oct.–1 Nov. 1967
(Contract AT(29-1)-789)
(SC-DC-67-2120; CONF-671021-1) CFSTI: HC $3.00/MF $0.65

A new control system for operating the pitching sector of the Sandia 18-inch Hypersonic Wind Tunnel was placed in operation. The system uses digital logic to provide continuous pitch or pitch-pause control over a maximum angle range of −10 to +20 degrees. Direct reading thumbwheel switches provided convenient digital adjustments of maximum pitch angle limits, pitch-increment angle, and pause time. Author (NSA)

N68-17363*# General Electric Co., Philadelphia, Pa.
EARLY POST-APOLLO CRYOGENIC FUEL PRODUCTION SYSTEM
John M. Greiner and Alan H. Singleton (Air Prod. and Chem., Inc.) *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 135–159 refs
(See N68-17350 08-30)

The design and performance characteristics of a system capable of producing liquid hydrogen and liquid oxygen from water on the lunar surface are described. The early requirements for water conservation and regeneration are indicated. The general design is composed of an electrolysis subsystem based on a reverse-cycle fuel cell, a liquefaction subsystem operating on a modified Claude cycle using the hydrogen produced by electrolysis as the working fluid, heat-rejection subsystems, an electrical power supply, and storage capabilities for the liquid hydrogen and liquid oxygen. The major components are discussed, and the system evaluation is presented. N.E.N.

N68-17549# Royal Aircraft Establishment, Farnborough (England).
A HYDRAULIC TRANSMISSION SYSTEM FOR POWERED WIND-TUNNEL MODELS
K. J. England Jul. 1966 29 p ref
(RAE-TR-66224)

A hydraulic transmission system is evaluated as a drive for wind tunnel model propellers and fans. The system compares favorably with existing electrical transmission systems and appears to have other applications in wind tunnel work. Author

N68-17674# Freie Univ., Berlin (West Germany).
EXPERIMENTAL INVESTIGATIONS ON BROAD BAND ADAPTATION OF ACCELERATION ELECTRODES FOR PARTICLE ACCELERATORS [EXPERIMENTELLE UNTERSUCHNGEN ZUR BREITBANDANPASSUNG VON BESCHLEUNIGUNGSELEKTRODEN BEI TEILCHENBESCHLEUNIGERN]
Dieter Moehl (Ph.D. Thesis) [1966] 17 p refs In GERMAN
(NP-17020)

A broad-band hf system is used for particle accelerators with magnetic fields, which are constant in time, and varying frequency. For broad-band adaptation, a network of RLC elements, cables, and cavity resonators were connected between the power amplifier and the acceleration electrodes. The possibilities and limitations on the reduction of the power requirements with broad-band adaptation were investigated. The maximum attainable power ratios were determined independently of the frequency characteristics of the network. Studies were made to determine how a given network with known characteristics is optimized. Criteria for the selection of the optimum frequency characteristics were given. The most favorable power ratios are obtained with networks with strong frequency-dependent transmission characteristics. In the comparison of the various types of networks, the working conditions of the amplifier must be considered. With a model system for a 150-MeV FFAG electronsynchrotron, a three-circuit system with 12 db pulse height of the transmission characteristic and an optimum adaptation system with flat characteristics were compared, and their utility in the accelerator was tested. The results showed that an improvement of the power was possible by adaptation of the frequency characteristics to the hf program of the accelerator. NSA

N68-17775# North American Aviation, Inc., Los Angeles, Calif.
GROUND-BASED SIMULATION TECHNIQUES Final Report
Dan W. Lew and Kenneth J. Dyda Oct. 1967 73 p refs
(Contract DA-44-177-AMC-406(T))
(USAAVLABS-TR-67-56; AD-663847)

Many methods have been used to correlate ground-based simulators with the actual aircraft they simulate. Comparisons of simulation with flight in past NAA/LAD programs are presented. They include dynamic checks, performance checks, and comparisons at the statistical level. Favorable comparisons not only validate the particular simulator involved but also give credence to the simulation process for future simulators. Good correlation between simulation and flight cannot be attributed to any one specific item. The overall handling and flying characteristics are embodied in the simulation process, but it is the attention to details which produce the distinguishing characteristics of a specific aircraft. Author (TAB)

N68-17835# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
ANALYSIS AND PARAMETER SPECIFICATION OF THE TEMPERATURE CONTROL FOR A GAS PLASMA FACILITY
John Charles Wiles, Jr. (M.S. Thesis) 15 May 1967 91 p refs
(GGC(EE)67-11; AD-663926)

The thesis deals with a control system which is under development and construction. Each individual component is analyzed either by empirical or experimental means and a linearized transfer function is determined. These transfer functions are combined and simplified in a block diagram which is composed of an inner current regulation loop and an outer temperature regulation loop. Root locus analysis of the inner loop gives the necessary gain adjustments for the inner loop amplifiers and feedback elements. An average inner loop forward amplifier gain of about 1.0 gives a damping ratio of 0.8. Analog analysis of the basic system gives a forward amplifier gain average of 316 which produces a 4.4 second time to peak and an 11 second settling time. The average ramp error of about 1.76 is reduced to 1.4 with a lead compensator, which also reduces the time to peak to 1.6 seconds and the settling time to 3.0 seconds. A lag-lead compensator reduces the ramp error to about 0.14 and an ideal integral plus proportional compensator reduces the ramp error to zero. Author (TAB)

N68-17930# California Univ., Berkeley. Lawrence Radiation Lab.
RAPID BEAM CUTOFF FOR 88-INCH CYCLOTRON
Henry S. Dakin and William W. Wadman 1 May 1967 15 p refs
(Contract W-7405-ENG-48)
(UCRL-17728) CFSTI: HC $3.00/MF $0.65

The design and operation of an electronic system is described which, upon an unexpected rise in cyclotron-produced radiation intensity, simultaneously sounds an alarm and deactivates the radiation source within 2×10^{-6} sec. Author (NSA)

N68-18034# Japan Atomic Energy Research Inst., Tokyo.
JRR-2 IRRADIATED FUEL STORAGE FACILITY
Sadamu Sawai and Mitsuyasu Ueno Jan. 1968 21 p
(JAERI-1153) CFSTI: HC $3.00/MF $0.65

The JRR-2 (Japan Research Reactor-2, CP-5 type) irradiated fuel storage facility has been used for over seven years, and many problems and troubles have arisen until now. Efforts have been made to overcome them and many of them were solved. This irradiated fuel storage facility and the experiences are described. The troubles and problems encountered, such as the pool lining, irradiated fuel storage rack, handling tools and so on, as well as the operation data on the water quality of the pool are also reported. Author

N68-18147# European Organization for Nuclear Research, Geneva (Switzerland).
INTERNATIONAL COLLOQUIUM ON BUBBLE CHAMBERS, VOLUME 2
H. Leutz, ed. Aug. 1967 201 p refs Proc. of the Colloq. held in Heidelberg, 13–14 Apr. 1967
(CERN-67-26, V. 2)

CONTENTS:

1. VIBRATION OF BUBBLE CHAMBER LIQUID DURING EXPANSION M. S. Dykes and G. Bachy (European Organization for Nuclear Res.) p 349–369 refs (See N68-18148 08-11)

2. POSSIBILITY OF A FAST CYCLING HYDROGEN BUBBLE CHAMBER J. Badier (Ecole Polytech.) p 371–377 (See N68-18149 08-11)

3. SPECIAL DEVICES FOR A FAST CYCLING HYDROGEN BUBBLE CHAMBER Ch. Gregory (Ecole Polytech.) p 379–387 (See N68-18150 08-11)

4. ON THE FORMATION OF BUBBLES IN LIQUID HYDROGEN G. Harigel, G. Horlitz, and S. Wolff (Deutsches Elektronen-Synchrotron) p 389–404 refs (See N68-18151 08-14)

5. BUBBLE DENSITY AND GROWTH OF BUBBLES IN PROPANE P. Kunkel, G. Christenn, and M. Scheer (Wuerzaerg Univ.) p 405–412 ref (See N68-18152 08-24)

6. TEMPERATURE MEASUREMENTS IN THE CERN 1 m^3 HEAVY LIQUID BUBBLE CHAMBER K. H. Eberle p 413–424 ref (See N68-18153 08-33)

7. THE SUPERCONDUCTING MAGNET ASSOCIATED WITH THE ANL 12-FT HYDROGEN BUBBLE CHAMBER E. G. Pewitt (Argonne Natl. Lab.) p 427–433 (See N68-18154 08-11)

8. 14-FT BUBBLE CHAMBER RESEARCH AND DEVELOPMENT PROGRAM MECHANICAL DESIGN DETAILS OF MAGNET COIL D. A. Kassner (Brookhaven Natl. Lab.) p 435–456 (See N68-18155 08-11)

9. MAGNET DEVELOPMENT PROGRAM FOR THE LARGE EUROPEAN HYDROGEN BUBBLE CHAMBER p 457–464 (See N68-18156 08-11)

10. CONTROL OF THE EXPANSION IN A HEAVY LIQUID BUBBLE CHAMBER BY ELASTICALLY SUSPENDED PLATES C. A. Ramm and Ch. Scherer p 467–471 (See N68-18157 08-11)

11. EXPANSION SYSTEM FOR THE LARGE EUROPEAN HYDROGEN BUBBLE CHAMBER p 474–478 (See N68-18158 08-11)

12. A FLAT MEMBRANE INFLATABLE GASKET FOR A LARGE LIQUID HYDROGEN BUBBLE CHAMBER R. G. Stierlin p 479–484 (See N68-18159 08-11)

13. OPTICS AND MAGNET OF THE HYDROGEN BUBBLE CHAMBER "MIRABELLE" M. Gensollen (Commissariat a l'Energie Atomique) p 485–492 (See N68-18160 08-11)

14. ENGINEERING ASPECTS OF THE ANL 12-FT HYDROGEN BUBBLE CHAMBER A. Tamosaitis (Argonne Natl. Lab.) p 493–500 (See N68-18161 08-11)

15. INSTRUMENTATION FOR THE ANL 12-FT HYDROGEN BUBBLE CHAMBER J. D. Simpson (Argonne Natl. Lab.) p 501–505 (See N68-18162 08-14)

16. EXPANSION SYSTEM FOR THE ANL 12-FT HYDROGEN BUBBLE CHAMBER J. D. Simpson (Argonne Natl. Lab.) p 507–511 (See N68-18163 08-11)

17. DESCRIPTION OF THE MECHANICAL AND ELECTRICAL COMPONENTS, GENERAL OVER-ALL, OPERATION AND EXPANSION STUDIES OF THE MURA MODEL HEAVY LIQUID BUBBLE CHAMBER C. A. Baumann, U. Camerini, W. F. Fry, M. C. Gams, R. H. Hilden, et al (Wis. Univ.) p 513–549 (See N68-18164 08-11)

N68-18148# European Organization for Nuclear Research, Geneva (Switzerland).
VIBRATION OF BUBBLE CHAMBER LIQUID DURING EXPANSION
M. S. Dykes and G. Bachy *In its* Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 349–369 refs (See N68-18147 08-11)

Techniques used in determining pressure variation and pressure time curves for a simple bubble chamber expansion system operating in a state of free oscillation are described. Results show that in a large bubble chamber of simple shape, acceptable pressure distribution and pressure time curves can be obtained with a relatively simple expansion system consisting of a piston and a latch mechanism, and an energy make-up device to replace the slight energy lossed during the oscillation. It was also found that : (1) heavy pistons can operate one-shot or in continuous oscillation, but with a relatively long pressure–time curves with possible difficulties due to spurious boiling; (2) if it were possible to construct a very light piston (i.e. C=0.2), it would then be possible with one-shot operation to have relatively fast pressure–time curves with good pressure uniformity in the region away from the piston. S.C.W.

N68-18149# Ecole Polytechnique, Paris (France).
POSSIBILITY OF A FAST CYCLING HYDROGEN BUBBLE CHAMBER
J. Badier *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 371–377 (See N68-18147 08-11)

Described are hypotheses which were formulated and tested in experiments performed with a 15 cm hydrogen bubble chamber. Experimental objectives were to determine whether bubble chamber projects could be improved by increasing the repetition rate. A possible set of parameters to operate a fast cycling chamber were derived, and the influence of temperature on the extinction of bubbles was verified. It is sumised that if the experimental assumtions were confirmed, a possible apparatus would be a chamber having a size of 80 cm; operable at 40 cycles per second. S.C.W.

N68-18150# Ecole Polytechnique, Paris (France).
SPECIAL DEVICES FOR A FAST CYCLING HYDROGEN BUBBLE CHAMBER
Ch. Gregory *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 379–387 (See N68-18147)

Described are modifications to special equipment used in fast cycling bubble chamber experiments. Discussed are changes to thermal regulation equipment, optic equipment and cameras, and the expansion system. S.C.W.

N68-18154# Argonne National Lab., Ill.
THE SUPERCONDUCTING MAGNET ASSOCIATED WITH THE ANL 12-FT HYDROGEN BUBBLE CHAMBER
E. G. Pewitt *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug.1967 p 427–433 Sponsored by AEC (See N68-18147 08-11)

Summarized briefly are engineering design and construction details for the superconducting coil to be used with the 12 ft hydrogen bubble chamber. Discussed are engineering problems inherent in the construction of a superconducting magnet for the 25

cm helium chamber; chamber assembly design concepts; coil support structure design; cooldown plumbing concepts; magnet parameters; and electrical circuit design concepts for the superconducting coil. S.C.W.

N68-18155# Brookhaven National Lab., Upton, N. Y.
14-FT BUBBLE CHAMBER RESEARCH AND DEVELOPMENT PROGRAM MECHANICAL DESIGN DETAILS OF MAGNET COIL
D. A. Kassner *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 435–456 Sponsored by AEC (See N68-18147 08-11)

Mechanical design details for a magnet coil which was incorporated into a one-half scale model of the 14 ft bubble chamber are reported. Objectives of these studies were to acquire additional data on fabrication and operating parameters of the 14 ft bubble chamber components, more specifically design concepts for superconducting coils that could be applied by scaling to the 14 ft magnet coil. S.C.W.

N68-18156# European Organization for Nuclear Research, Geneva (Switzerland). Study Group for a Large European Bubble Chamber.
MAGNET DEVELOPMENT PROGRAM FOR THE LARGE EUROPEAN HYDROGEN BUBBLE CHAMBER
In its Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 457–464 (See N68-18147 08-11)

Discussed are technical specifications for the large European hydrogen chamber magnet system which will be used in tests of superconductors under mechanical and magnetic stresses. Described are plans for developing test facilities, a shielding box, and proposed conductor geometries for magnet coils. S.C.W.

N68-18157# European Organization for Nuclear Research, Geneva (Switzerland).
CONTROL OF THE EXPANSION IN A HEAVY LIQUID BUBBLE CHAMBER BY ELASTICALLY SUSPENDED PLATES
C. A. Ramm and Ch. Scherer *In its* Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 467–471 (See N68-18147 08–11)

Results of experiments in which a freely suspended rigid plate was used to control membrane boiling in a heavy liquid bubble chamber are reported. Experiments were based on the premise that an elastically suspended rigid plate in front of the membrane would have the effect to force a piston-like type of expansion due to the restricted circulation of liquid behind the plate during a rapid expansion cycle, and that the plate would create two dimensional rigidity in the flow pattern of the liquid. Preliminary trials were performed using a simple disc made from 8 mm Anticorodal Al Mg Si sheet cut to provide its own supports. Results were an improved cycle and the absence of parasitic boiling on the plate. Also, a more elaborate plain disc version with four separate guiding arms and torsion bars located between membrane and plate was designed and successfully operated in freon C_2ClF_5, freon CF_3Br, and propane. With a black paint coated surface (polyurethane or acrylic paint in freon), the plate was free of parasitic boiling and gave excellent black background. Also, lifetime was superior to 8.10^5 pulses with Anticorodal torsion bars and better performance is expected from titanium alloy (Ti Al V) bars on which limited experience is available. To compensate for gravity effects, torsion bar attachments were adjusted. For the given plate size and type of suspension, a radial gap of 4 mm between plate edge and chamber body was adequate. S.C.W.

N68-18158# European Organization for Nuclear Research, Geneva (Switzerland). Study Group for a Large European Bubble Chamber.
EXPANSION SYSTEM FOR THE LARGE EUROPEAN HYDROGEN BUBBLE CHAMBER
In its Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 474–478 (See N68-18147 08-11)

Concepts for the design of the driving mechanism (motor) for the expander of a larger hydrogen bubble chamber are described. The expansion system proposed for the 3.5 m chamber which is a resonant type system combined with a hydraulic locking device is described. A development program for a scale model of the expansion motor applicable to the 1 m test chamber is also discussed. The 1 m test chamber has a hydrogen volume of about 1 m^3. The diameter of the cold piston is 600 mm and the necessary piston stroke for a volumetric expansion of 1% is 35 mm. With this chamber, the phenomena of bubble growth and dynamic heat load as a function of the pulse width of the expansion cycle will be studied. S.C.W.

N68-18159# European Organization for Nuclear Research, Geneva (Switzerland).
A FLAT MEMBRANE INFLATABLE GASKET FOR A LARGE LIQUID HYDROGEN BUBBLE CHAMBER
R. G. Stierlin *In its* Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 479–484 (See N68-18147 08-11)

Manufacturing methods and techniques used in the development of flat membrane inflatable gaskets for the 2 m liquid hydrogen bubble chamber; are described. The purpose of the gaskets is to ensure leak tightness between the volume formed by the chamber and its attached safety tanks, and that of the surrounding vacuum tank during cool-down and warming-up operations. Four gaskets mounted on the 2 m chamber have been in service for 8 months and have previously been submitted to a pneumatic pressure test at 100 atmosphere in liquid nitrogen with a total deflection limited to that of service. Tests of small gaskets of similar construction which will be used to seal the camera and flash windows of the safety tanks are being prepared. S.C.W.

N68-18160# Commissariat a l'Energie Atomique, Saclay (France). Centre d' Etudes Nucleaires.
OPTICS AND MAGNET OF THE HYDROGEN BUBBLE CHAMBER "MIRABELLE"
M. Gensollen *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 485–492 (See N68-18147 08-11)

Design details for the magnet and optical systems of the Mirabelle hydrogen bubble chamber are described. Design of the magnet and the checking of various characteristics are being carried out on a 1/25 scale model which has been equipped with superconducting coils in order to reach the desired current density. Results of magnet tests will be used for predetermining the map of the magnetic field in the useful volume of the chamber and for optimizing the shape of the hole pieces with respect to field homogeneity. Variations of the field are expected to be lower than 7% on the axis of the chamber and 5% in a transversal cross section. The lens system consists of two parts. A cold part of fish eye type made up of a single spheric window, and of a parabolic lens which reduces the field from 110° to 10°. Design specifications for a prototype system are reviewed. Proposed specifications for the camera system are also briefly reviewed. S.C.W.

N68-18161# Argonne National Lab., Ill.
ENGINEERING ASPECTS OF THE ANL 12-FT HYDROGEN BUBBLE CHAMBER
A. Tamosaitis *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 493–500 Sponsored by AEC (See N68-18147 08-11)

Engineering problems imposed by the size of the 12 ft hydrogen bubble chamber are discussed. Considered are size induced operational problems, and problems associated with the photographic and expansion systems. Efforts to solve and/or prevent the recurrence of size related problems are detailed. S.C.W.

N68-18163# Argonne National Lab., Ill.
EXPANSION SYSTEM FOR THE ANL 12-FT HYDROGEN BUBBLE CHAMBER

J. D. Simpson *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 507–511 Sponsored by AEC (See N68-18147 08-11)

Design criteria, operating principles, and pressure gradient problems of the 12 ft hydrogen bubble chamber; are outlined. S.C.W.

N68-18164# Wisconsin Univ., Madison.
DESCRIPTION OF THE MECHANICAL AND ELECTRICAL COMPONENTS, GENERAL OVER-ALL, OPERATION AND EXPANSION STUDIES OF THE MURA MODEL HEAVY LIQUID BUBBLE CHAMBER

C. A. Baumann, V. Camerini, W. F. Fry, M. C. Gams, R. H. Hilden et al *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 513–549 (See N68-18147 08-11)

Presented is a general description of mechanical and electrical components; bubble chamber electronic equipment; general operation; and expansion studies of the Mura Model experimental heavy liquid bubble chamber. S.C.W.

N68-18190*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FEASIBILITY STUDIES OF A SHORT DURATION HIGH REYNOLDS NUMBER TUBE WIND TUNNEL

John W. Davis and Hal S. Gwin 9 Jan. 1968 56 p refs
(NASA-TM-X-53571) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A relatively inexpensive short duration test facility is described in which extremely high Reynolds number flows are practical in the subsonic, transonic, and supersonic speed ranges. Bacially, the method described is a type of blowdown wind tunnel in which the air storage vessels have been replaced by a long tube filled with high pressure gas. Upon bursting of a diaphragm, a short duration steady flow is achieved behind the centered rarefaction fan which propagates into the supply tube. Useful testing may be accomplished during this period by expanding the gas to the desired test condition by conventional means. Experimental results are presented indicating primarily the transient starting characteristics of a small scale pilot model facility tested. Experimentally determined test data showed close agreement with those predicted by unsteady expansion theory. Author

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N68-17226# New York Univ., N. Y. Geophysical Sciences Lab.
TRANSVERSE JET PLUMES Technical Progress Report, 1 Nov. 1966–30 Nov. 1967

James Halitsky, Irving Karmin, and Stanley Liu 1 Dec. 1967 26 p
(Contract AT(30-1)-3673)
(NYO-3673-2) CFSTI: HC $3.00/MF $0.65

The structural phase of the water tower conversion to a field station was completed. The fixed platform and rotatable instrument carriage were assembled on the ground. Work on the air system for creating a plume was begun. The hollow riser which will serve as an air conduit between the fan on the ground and the test stack was opened and reinforced. Special instrumentation for the tunnel tests was built. The characteristics of the oscillating air stream produced in the tunnel by the vane mechanism were checked and a computer model for mathematically oscillating a steady-wind plume developed. No experiments were run since the field station was not ready. NSA

N68-17303# Royal Aircraft Establishment, Farnborough (England).
MEASUREMENTS IN A THREE-DIMENSIONAL TURBULENT BOUNDARY LAYER IN SUPERSONIC FLOW

M. G. Hall and H. B. Dickens Jul. 1966 66 p refs
(RAE-TR-66214) CFSTI: HC $3.00/MF $0.65

Details are given of the results of measurements of mean values in time of pitot pressure and flow direction made in the boundary layer over the insulated side-wall of a specially constructed supersonic nozzle. The external flow first accelerated and decelerated, and the cross-wise pressure gradients were such that the boundary-layer cross-flow was first in one direction and then in the opposite, as happens over wings with swept leading edges. The external Mach number ranged between 1.6 and 2.0. Boundary-layer traverses were made at intervals along external streamlines; from each traverse, profiles of Mach number and streamwise and cross-wise components of velocity were derived. The results were supplemented by measurements of skin friction using surface tubes, and displacement and momentum thicknesses were evaluated. All the results are presented in tabular form, and a discussion is given in which serious limitations in the commonly assumed forms for the cross-flow profiles are pointed out. There is evidence, however, that the streamwise component behaves as it would in an equivalent two-dimensional boundary layer. Author

N68-17376*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PRESSURE AND FLOW FIELD STUDY AT MACH NUMBER 8 OF FLOW SEPARATION ON A FLAT PLATE WITH DEFLECTED TRAILING EDGE FLAP

Charles B. Johnson Washington Mar. 1968 99 p refs
(NASA-TN-D-4308) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An experimental investigation was made of the flow separation on a flat plate model with a short trailing-edge flap deflected at angles of 10°, 20°, and 30° relative to the plate surface. These tests were conducted at a nominal free-stream Mach number of 8 and the nominal free-stream unit Reynolds number per foot was varied from 0.22×10^6 to 10.9×10^6. Pressure measurements and schlieren studies were made for wall-to-total temperature ratios. Surface oil-flow studies were made at a wall-to-total temperature ratio of 0.43. Local similarity boundary-layer calculations were made upstream of the interaction region. Properties of the interaction and separated flow region were calculated with the boundary-layer–shock-wave interaction theory. Author

N68-17422# Strathclyde Univ., Glasgow (Scotland).
BOUNDARY LAYER SEPARATION APPLIED TO THRUST VECTOR CONTROL

R. V. Thompson *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 223–238 refs (See N68-17413 08-31)

The phenomenon of boundary layer separation is used to advantage in the operation of a high-pressure, bi-stable, fluid switch. Jets of air, which are expanded through a non-adapted, convergent–divergent, two-dimensional duct at pressure ratios in excess of critical, can be encouraged to change their flow vector by the transverse introduction of further air at atmospheric pressure via strategically positioned control ports. The positions of separation and reattachment of the main jet have been determined experimentally by the Schlieren process and verified by pressure tappings along the flow boundaries. An indication of the results so obtained is included in the text. Of prime interest are the suggested modes of operation, i.e. pressure feedback in the boundary layer and the pinpointing of separation and reattachment points. Author (ESRO)

N68-17429*# Brown Engineering Co., Inc., Huntsville, Ala. Advanced Systems Labs.
AN EXPERIMENTAL STUDY OF THE FLOW VARIABLES AT THE MINIMUM PRESSURE STATION OF NINETY-DEGREE PIPE BENDS

G. R. Guinn and G. P. Stricklin Nov. 1967 56 p refs
(Contract NAS8-20073)
(NASA-CR-61576; RL-243) CFSTI: HC $3.00/MF $0.65 CSCL 20D

To support liquid cavitation studies, flow variables were measured which relate to the minimum pressure in 90-degree circular pipe bends. All of the bends investigated were nominally 4 inches in diameter and had ratios of curvature radius to pipe diameter of 2.00, 1.50, 1.25, 1.00, and 0.75. Water was used as the test medium and the Reynolds number ranged from 2.5×10^5 to 0.8×10^6. To locate the minimum wall pressure, static pressures were first measured at the inner and outer walls in the plane of curvature. The minimum wall pressure was found to occur between 22.5 degrees and 30 degrees deflection angle along the inside wall. Velocity and pressure transverses were then made across the bend at the position of minimum pressure. The total pressure was found to be roughly uniform in the central core and the velocity profile was found to correspond generally to that for free vortex flow. It was found that minimum pressures in the bend could be approximated by free vortex flow; however, the predicted values will be conservative, e.g., low, when viewed from the standpoint of cavitation. Author

N68-17563*# National Aeronautics and Space Administration, Washington, D. C.
CALCULATION OF THE TURBULENT BOUNDARY LAYER AND OF TRANSITION ON A PLANE PLATE [ESSAI DE CALCUL DE LA COUCHE LIMITE TURBULENTE ET DE LA TRANSITION SUR UNE PLAQUE PLANE]
R. Hirsch Feb. 1968 191 p refs Transl. into ENGLISH from Publ. Sci. Tech. Min. Air (France), no. 393, 1963
(NASA-TT-F-520) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Calculations of the turbulent boundary layer and transition on a plane plate are derived in detail, including the following: study of a solution of two Navier–Stokes equations inducing a stationary field analogous to the average turbulent field; existence of an asymptotic solution and determination of the development of friction; study of the effect of an exterior harmonic perturbation of wavelength λ. For a critical Reynolds number of 0.0037, the Blasius state is unable to exist and must be replaced by the newly developed state. The perturbations permitting such substitution and formed over the segment of $1/2\ R_c$ are derived, and the calculations are extrapolated to the compressible state with heat exchange. Comparisons of the results with practical experiments show agreement with the Blasius theory of the laminar regime. A possibility exists to maintain the laminar state by replacing the rigid wall with an elastic membrane whose tension would be made dependent on the pulsation of the exterior perturbation which ordinarily causes passage to the turbulent state. Author

N68-17655# RAND Corp., Santa Monica, Calif.
THE RICE AND WALSH EQUATION OF STATE FOR WATER: DISCUSSION, LIMITATIONS, AND EXTENSIONS
R. A. Papetti and M. Fujisaki Dec. 1967 59 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5050-PR; AD-663731)

An equation of state of water is examined in detail for the purpose of constructing a set of equilibrium relations for water over a range of thermodynamic variables suitable for nuclear burst and hypervelocity calculations in water. Analytic expressions and quadratures for the numerical results of Rice and Walsh are obtained, as well as approximate bounds on the region of validity of their method. The study also extends their results for the enthalpy-pressure-volume and energy-pressure-volume relations to 450 kilobars and presents a method for extrapolating a strip of the enthalpy-pressure-volume and energy-pressure-volume surfaces containing the Hugoniot curve to the Thomas-Fermi region (assumed to have a minimum pressure of 10 megabars). Author (TAB)

N68-17702# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CERTAIN PROPERTIES OF HIGH-SPEED CUMULATIVE JETS [O NEKOTORYKH SVOYSTVAKH VYSOKOSKOROSTNYKH KUMULYATIVNYKH STRUY]
N. P. Novikov *In its* J. of Appl. Mech. and Tech. Phys., no. 1, 1963 14 Apr. 1967 p 1–14 refs (See N68-17701 08-23)

This article gives experimental study results on the formation of maximum speeds of high-speed cumulative jets and considers the peculiarities of jet interactions with a barrier and their passage through a hole. Author

N68-17727# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF ROTARY AND OSCILLATORY RELAXATION ON LAMINAR BOUNDARY LAYER ON PLATE [VLIYANIYE VRASHCHATEL'NOY I KOLEBATEL'NOY RELAKSATSII NA LAMINARNYY POGRANICHNYY SLOY NA PLASTINKE]
Yu. P. Lun'kin and Si-tsin' Yan *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 253–259 refs (See N68-17701 08-23)

During flight by bodies at supersonic speeds, the temperature of gas close to their surface may greatly exceed ambient temperature. Such increase in temperature is accompanied by excitation of gas molecules. However, this excitation is not effected instantly, but over a certain time, which is called relaxation time. This article gives some of the results of research into unbalanced excitation of rotary and vibrational degree of freedom in laminar boundary layer on flat plate. A method of approximate solution for the system of equations describing this phenomenon is given. Author

N68-17728# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF GEOMETRIC CHARACTERISTICS OF PERFORATED SHEET ON REMOVAL OF HEAVY COMPONENT DURING BUBBLING [VLIYANIYE GEOMETRICHESKIKH KHARAKTERISTIK DYRCHATOGO LISTA NA VELICHINU UNOSA TYAZHELOY KOMPONENTY PRI BARBOTAZHE]
V. B. Zhinkina, I. G. Malenkov, and V. N. Moskvicheva *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 261–266 ref (See N68-17701 08-23)

The bubbling through liquid gas of other immiscible fluids has found wide practical application in the most varied branches of industry and especially in boiler engineering and chemical technology. The most intense carry-away starts after there has been a structural rearrangement of the layer, i.e. when the given speed of light component attains a so-called critical value. Considered is the influence of given speed and input conditions on light component removal in the supercritical region. Experimental introduction of a light component into a column layer was effected through replaceable perforated sheets with different geometric characteristics: diameters of holes d = 2, 3, 5 and 8 mm; cross section of sheets ϕ = 2, 3, 4.5, 5, 8, 12.5%. All experiments were conducted in the system water–mercury with a given height of layer h' = 72 mm. The obtained experimental material shows the influence of heavy component removal. Author

N68-17740# Coating and Chemical Lab., Aberdeen Proving Ground, Md.
WATER EQUILIBRATION STUDIES—BRAKE FLUIDS
Edward A. Mains Dec. 1967 34 p refs
(CCL-231; AD-663812)

The water absorption characteristics of various types of hydraulic brake fluids were studied at controlled humidities. Three series of tests were conducted using a wide scope of brake fluid types exposed to relative humidities ranging from 20% to 80%. Rates and amounts of water absorption were determined. Moisture equilibration percentages were obtained. Boiling point depression

was correlated with water concentration. All fluids tested were found to absorb water to varying degrees over the entire humidity range. Boiling points were drastically reduced with only small amounts of water. Fluids equilibrated at one relative humidity were found to desorb water when exposed to a lower humidity. Author (TAB)

N68-17762# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Aachen (West Germany). Inst. fuer Theoretische Gasdynamik.
THE INFLUENCE OF SURFACE CURVATURE ON TWO-DIMENSIONAL LAMINAR BOUNDARY LAYERS [DER EINFLUSS DER KRUEMMUNG BEI ZWEIDIMENSIONALEN LAMINAREN GRENZSCHICHTEN]
I. Teipel Jan. 1968 37 p refs In GERMAN; ENGLISH summary
(DLR-FB-68-01) CFSTI: HC$3.00/MF$0.65

The steady, incompressible, laminar boundary layer flow has been calculated including effects of longitudinal surface curvature. For special cases of the potential flow one can find similarity solutions. The differential equations that one receives by this method have been solved numerically. As result one gets that the boundary layer thickness increases with growing curvature while the skin friction coefficient decreases. Besides the velocity profiles displacement, momentum and energy thickness are given. All calculations have been carried out only for convex surfaces. Author

N68-17856# Stanford Univ., Calif. Thermosciences Div.
HYPERSONIC LAMINAR SEPARATION IN MINUTELY BLUNTED CONES IN SLIP FLOW
Harvey H. Album May 1967 302 p refs
(Contract AF 49(638)-1278)
(HS-1; AFOSR-67-1507; AD-663475)

The primary purpose of the investigation was to study hypersonic, laminar, axisymmetric compression-separation with significant transverse curvature on an isothermal, but slightly cooled wall. Experiments were conducted in a hypersonic wind tunnel using a 5-degree half-angle cone with four flare compression-surface angles. The free stream Mach number was about 14.5 at the model tip. The free stream was slightly divergent. A number of peripheral problems were investigated; among these are the effects on the flow of: the slightly divergent freestream, minute tip-bluntness, slip-flow, and shock viscous-layer interactions. All of these factors influenced the flow upstream of separation-interaction. A qualitative analysis indicates that the separated regions were significantly altered by the effects of the slight free-stream non-uniformity. Nevertheless, surface pressure distributions for three separation-interaction regions are still correlated by parameters developed from a simplified, semi-empirical, hypersonic, laminar, free-interaction analysis. The experimental observation techniques included detailed surface pressure measurements, pitot surveys of the separated flow (which were converted into velocity and Mach number profiles), Tempilag fluid-flow studies and the use of pure-carbon tufts. The flow-visualization techniques are an advance in the experimental art because they are applicable at high surface temperatures, i.e., temperatures at 1460 R and perhaps beyond. However, these techniques were not fully exploited in the investigation. Author (TAB)

N68-17873# ARO, Inc., Arnold Air Force Station, Tenn.
THE COLLECTION OF A NORMALLY INCIDENT LOW DENSITY SUPERSONIC STREAM BY A CRYOGENIC SURFACE Final Report, Jan. 1965-Jun. 1967
W. B. Stephenson Arnold Eng. Develop. Center Jan. 1968 73 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-67-201; AD-663755)

An experimental investigation was made to determine the amount of a low density supersonic (M approx. = 3) gas stream that will condense on a cryogenic surface at normal incidence. Nitrogen and argon flows up to .002 gm/sec/sq cm, at total temperatures from 300 to 750K condensed on a liquid- or gaseous-helium-cooled plate. The amount collected was related to the stream properties and the heat transfer to the coolant. The analysis indicates that the cryosurface tends to a steady temperature at which the net rate of collection is the incident stream flux minus the evaporation rate for that temperature. This model provides a basis for the design of cryopumping geometries for low density directed flows such as jet plumes or wind tunnel nozzles. Author (TAB)

N68-17877# Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.
INVISCID FLOWS OF STABLY STRATIFIED FLUIDS OVER BARRIERS
Yih-ho Pao Sep. 1967 48 p refs
(D1-82-0646; Rept.-117; AD-663602)

Steady, inviscid, incompressible, two-dimensional flows of stably stratified fluids over a barrier or barriers are examined theoretically. The density gradient and u sub rho to the 1/2 power are assumed to be constant upstream, where rho is the density and u is the horizontal velocity. Exact solutions of large amplitude waves valid for arbitrary Richardson numbers are obtained for barriers of finite height in a semi-infinite domain or in a confined channel. These barriers are constructed from vortex pairs and doublets. Author (TAB)

N68-17887# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EFFECT ON THE LUBRICATING PROPERTY OF A SURFACE ON THE TRANSFER PROCESS IN SYSTEMS CONSISTING OF A DROP-FORM LIQUID AND A SOLID [VLIYANIYE SMACHIVAYEMOSTI POVERKHNOSTI NA PROTSESSY PERENOSA V SISTEMAKH KAPEL'NAYA ZHIDKOST'-TVERDOYE TELO]
B. M. Smol'skiy and I. T. El'perin 15 Jun. 1967 15 p refs Transl. into ENGLISH from the book "Teplo- i Massoobmen Tel s Okruzhayushchey Gazovoy Sredoy" Minsk, Izd. Nauka i Tekhn., 1965 p 130–137
(FTD-HT-66-595; AD-663621)

A determination was made of the hydrodynamic friction resistance in the flow of a fluid in tubes. Determinations were made of the friction coefficients of tubes made of various materials. The walls of the tubes were rubbed previously with distilled water and with various surface active agents. The effect of the surface active agents appears gradually and reaches a maximum after a period of from 1 to 10 minutes, after which it remains constant. The effect of pulsation velocity and lubricating properties on the lowering of the critical Reynolds number is considered. Measurements were made of the temperature of the water, its flow rate through the tube, the duration of the test, and the frequency of the pulsations. The equipment permitted visual observation of the transition point from laminar to turbulent flow, and determination of the critical Reynolds number, which lay within the limits of 2250-2350. A second series of experiments was made to determine the effect of lubricating properties on the lowering of the critical Reynolds number. It was found that, with application of pulsation to flow in a tube which has been treated with surface active agents, the critical Reynolds number has lowered to 1200-1300. Finally, the article considers the effect of lubricating properties on heat transfer. TAB

N68-17903# Aerospace Corp., El Segundo, Calif. Aerodynamics and Propulsion Research Lab.
RESTRICTED VARIATIONAL PRINCIPLE METHOD FOR THE MIXING OF PARALLEL LOW-DENSITY STREAMS
Charles R. Ortloff Oct. 1967 32 p refs
(Contract F04695-67-C-0158)
(TR-0158(3240-20)-2; SAMSO-TR-67-122; AD-663720)

Rosens restricted variational principle representation of the Boltzmann equation is used to analyze the mixing of two initially

parallel low-density hypersonic streams. The mixing occurs as a result of convective, thermal, and collisional motions of the gas particles. Mixing zone, number density, and velocity profiles for a variety of initial temperature and velocity ratios are given for the Knudsen number range infinity < Kn < 0.2. Author (TAB)

N68-17908# Aerospace Corp., El Segundo, Calif.
A STUDY OF PENETRATION OF A LIQUID INJECTANT INTO A SUPERSONIC FLOW
Kenneth P. Horn, Marc A. Kolpin, and Roy E. Reichenbach Oct. 1967 46 p refs
(Contract F04695-67-C-0158)
(TR-0158(3220-10)-1; SAMSO-TR-67-65; AD-663417)

The paper reports a study of normal and lateral spray penetration for small diameter, high pressure, liquid jets issuing at an angle to a uniform supersonic stream. The experimental program described was carried out in a 4-in. by 4-in. blow down supersonic wind tunnel. The flow field is observed by means of a Schlieren system, and the spray distribution is indicated by the light scattered by the liquid droplets. The data on normal penetration, in good agreement with data inferred from other investigations, indicate that a single-parameter correlation exists between the properly nondimensionalized penetration height and the injection pressure ratio. Injecting the coolant at a forward angle to the flow produces no substantial change in the penetration height. The data on lateral penetration show the spray width behind the jet to be proportional to the jet diameter with only a weak dependence on the injection pressure ratio. Analytical models proposed by previous investigators are critically examined in light of the results. No single model leads to a proper scaling law for both normal and lateral penetration. Author (TAB)

N68-17911*# Southwest Research Inst., San Antonio, Tex.
DRAG COEFFICIENTS FOR FLAT SQUARE PLATES OSCILLATING NORMAL TO THEIR PLANES IN AIR Final Report
William E. Woolam Mar. 1968 52 p refs
(Contract NAS1-6659; SwRI Proj. 02-1973)
(NASA-CR-66544) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An investigation was conducted to determine the drag coefficients for flat plates oscillating normal to their planes. With this specific objective in mind, a dimensional analysis was performed from which several dimensionless parameters were chosen for a detailed experimental study. These parameters include amplitude of oscillation, frequency of oscillation, plate thickness, and area. The present study indicates that the oscillatory drag coefficient is a function of the plate area to the four-thirds power, which is in agreement with earlier investigations by Stephens and Scavullo. There is evidence that over a frequency range of 0.48 to 21.2 Hz, the oscillatory drag coefficients are independent of the frequency of the plate oscillation. Within the range of parameters considered, there appears to be an indistinguishable effect of both the plate thickness and the amplitude of oscillation on the oscillatory drag coefficient. Author

N68-17943# Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.
LAMINAR FLOW OF A STABLY STRATIFIED FLUID PAST A FLAT PLATE
Yih-ho Pao Sep. 1967 84 p refs
(D1-82-0488; Rept.-102; AD-663664)

Laminar flow of a stably stratified fluid with uniform upstream velocity and density gradient past a flat plate is investigated experimentally and theoretically. In the experimental study, the flat plate, parallel to the direction of motion, is towed horizontally at various constant speeds in a tank of stratified salt water at various density gradients. The density before each run is measured with a single electrode conductivity probe. The horizontal velocity in front of, above, and behind the flat plate are measured with a flow visualization technique. One of the striking phenomena is the strong upstream influence (the upstream wake) of an obstacle in a flow of stably stratified fluid when the gravity effect is comparable to, or more than the inertial effect. The velocity profiles of the upstream wake and boundary layer above the flat plate are wavy and found to be strongly governed by the ratio of Reynolds number Re to Richardson number Ri. The problem is also analyzed theoretically with Boussinesqs approximation and two-parameter asymptotic expansions for the far and near fields. The solution of the far-field first-order expansion is compared with the measured upstream wake. The near-field zeroth order solution (boundary layer solution) is compared with measurements above the plate. Author (TAB)

N68-17951# North American Rockwell Corp., Anaheim, Calif. Ocean Systems Operations.
ACOUSTIC AND BOUNDARY LAYER FLOW CHARACTERISTICS OF A FREE-FALL STREAMLINED BODY IN THE OCEAN Final Report, Sep. 1964–Nov. 1967
D. E. McNay, V. C. Plane, J. O. Hall, and G. Cleveland Nov. 1967 49 p refs
(Contract Nonr-4669(00))
(C7-3073/020; AD-663747)

Acoustical data on vehicle boundary layer flow was obtained on a 19-inch diameter, negatively buoyant body of revolution in free-fall through the upper layers of the ocean. The extent of laminar flow over the forward portion of the laminar airfoil shaped body varied from near zero to more than 55 percent of the basic body length of 63 inches. The extent of laminar flow was varied both by design, using boundary layer trips at different locations on the surface, and by the natural environmental conditions of the ocean. The most significant environmental influence was the varying relative ambient turbulence encountered by the vehicle as it passed with increasing speed through regions of differing characteristics, in its vertical dive from the surface. Within the experimental evidence, there is significant correlation between the sudden increase in the extent of laminar flow and the discontinuities in the temperature profile with depth as indicated by the bathythermograph record. The sound pressure spectrum level received at the nose of the vehicle as a self-noise measurement also shows significant correlation with the indicated extent of laminar flow. The analysis of the limited sound data leads to the conclusion that the sound levels in the 20 to 40 kHz range, received at the nose-mounted hydrophone, decrease as the transition zone from laminar to turbulent flow moves aft on the body. Author (TAB)

N68-18010# Ballistic Research Labs., Aberdeen Proving Ground, Md.
THE EFFECTS OF SOLID STRENGTH ON THE PROPAGATION AND ATTENUATION OF SPHERICAL AND PLANE SHOCK WAVES
Chi-Hung Mok Oct. 1967 91 p refs
(BRL-R-1375; AD-663820)

To demonstrate the titled effects, basic equations in Lagrangian coordinates are derived for spherical and plane waves in an elastic-perfectly plastic solid. The solution is first discussed qualitatively on the basis of the method of characteristics and then is obtained numerically by using a finite difference method for a shock wave induced by a square stress pulse in time at a boundary. In agreement with Frasiers preliminary conclusions from the results of hypervelocity impact experiments in wax, the results show that the effects of solid strength are significant when the strength of the shock wave is within two orders of magnitude of the yield stress of the material. It is also indicated that precise control of the loading process is necessary to detect experimentally the possible effects of solid strength on the attenuation of shock waves. Author (TAB)

N68-18024# Polytechnic Inst. of Brooklyn, N. Y. Dept. of Aerospace Engineering and Applied Mechanics.
A STUDY OF THREE-DIMENSIONAL, INCOMPRESSIBLE, TURBULENT WALL JETS Interim Scientific Report
Pasquale M. Sforza and Gary Herbst Oct. 1967 103 p refs
(Contract AF 49(638)-1623)
(PIBAL-1022; AFOSR-67-2580; AD-663423)

The report presents an experimental investigation of the mean properties of turbulent, three-dimensional, incompressible air jets issuing into a quiescent air ambient from various rectangular orifices parallel to, and at the surface of, a flat plate. An analytical approach to estimate the shear stress distribution at the plate is also presented. The flow field of a three-dimensional wall jet is found to be characterized by three distinct regions in the axis velocity decay. From the results obtained it is concluded that for three-dimensional wall jets the maximum velocity in the flow in the near field exhibits a decay rate dependent on orifice geometry, while far downstream of the jet exit it decays at the same rate as that in a radial wall jet flow field independent of orifice geometry. Furthermore, it is shown that the growth of the mixing layer normal to the plate is apparently independent of orifice shape while the near field spanwise growth is affected by initial geometry. Irregularities in the spanwise distribution of streamwise mean velocity attest to the strong three-dimensionality in the near field of the wall jets studied. These irregularities are manifested as local excesses, or defects, in the velocity profile. Such results indicate that the characterization of the wall jet flow field generated by a finite slot as quasi-two-dimensional may be of questionable validity. Author (TAB)

N68-18029# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany).
EXPERIMENTS ABOUT THE GENERATION OF UNIFORM SIZED LIQUID DROPLETS [EXPERIMENTE ZUR ERZEUGUNG VON FLUESSIGKEITSTROPFEN GLEICHER GROESSE]
J. Thelen, W. Trommsdorff, H. Wiegand Dec. 1967 60 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-91; DVL-609)

The report deals with experimental generation of uniform-size droplets by influence of sound or ultrasound on liquid jets. The liquid was injected in calm air of atmospheric pressure or in a low-pressure chamber. Before describing the experiments, there are made theoretical considerations about generation and stability of serial droplets, that are based on known publications. The apparatus for generation of liquid droplets and the measuring designs are described in detail. Author

N68-18058# Royal Aircraft Establishment, Farnborough (England).
TWO-DIMENSIONAL LAMINAR COMPRESSIBLE BOUNDARY LAYER PROGRAMME FOR A PERFECT GAS
C. C. L. Sells Aug. 1966 77 p refs
(RAE-TR-66243)

A computer program has been written to solve the steady laminar two-dimensional boundary layer equations for a perfect gas at given wall temperature, without wall suction. The program solves the equations at a blunt stagnation point and then solves the equations downstream. Versions for Mercury and Atlas are available. The Atlas program will permit use of linear or Sutherland viscosity laws. Directions are given for setting up problems for solution; the inviscid edge velocity and wall enthalpy, as functions of downstream arclength along the body, are at the programmer's disposal. It appears possible to obtain results correct to at least three significant figures. Author

N68-18074# Aerospace Corp., El Segundo, Calif. Lab. Operations.
SUBSONIC FLOW OF HOT GAS THROUGH A HIGHLY COOLED CONSTANT-AREA CHANNEL
Harold Mirels Nov. 1967 31 p refs
(Contract F04695-67-C-0158)
(TR-0158(3240-10)-3; SAMSO-TR-67-119; AD-663419)

Laminar flow of a hot viscous gas through a highly cooled, constant-area, semi-infinite channel is considered. An exact solution is obtained for the limit where the flow Mach number is low, the gas enthalpy at the wall is small compared with the centerline value, the Prandtl number is one, and the ideal gas equation of state is applicable. The resulting solution is one in which the pressure and axial mass flux is everywhere constant. For $m = 0$, the problem is equivalent to a heat conduction problem, and the solution for the flow throughout the tube is known. Numerical results are obtained for m not = 0 that describe the flow in the inlet region and in the fully developed flow region. In the latter region, the normalized velocity, enthalpy, and reciprocal density profiles are all identical and remain invariant with streamwise distance. The physical amplitudes of these quantities decrease in the streamwise direction as a result of wall shear and heat transfer. Author (TAB)

N68-18094*# General Electric Co., Philadelphia, Pa. Missiles and Space Div.
THE STATUS OF OPTICAL DIAGNOSTICS ON WAKES BEHIND HYPERSONIC VEHICLES
James C. Burns and T. R. Riethof *In* NASA. Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 237-250 refs (See N68-18082 08-33)

Measurements of the radiation from the wake left by a body moving through the atmosphere at hypersonic speeds can yield diagnostic information on vehicle performance, on flow field properties and, where the atmosphere is unknown, on the atmosphere itself. Experimental techniques for making such measurements, including controlled laboratory work in ballistic ranges, vehicle-borne experiments, and remote off-board observations are reviewed, and the scope and limitations of the information which can be derived from the data are discussed. Author

N68-18098*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
REMOTE DETECTION OF LOCAL TEMPERATURES AND LOCAL PARTIAL PRESSURES WITH CROSSED-BEAM SPECTROSCOPY
Fritz R. Krause and J. B. Stephens *In its* Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 297-327 refs (See N68-18082 08-33)

The physical interpretation of crossed-beam tests is formulated mathematically for a set of experiments, which differ only by using a different optical wave number for one of the two photometer units. Two passive remote detection systems are used to select a region from triangulation of the two beams. The beam modulations are multiplied and averaged over time to discriminate against all beam modulations which originate outside the selected region. The measurements of the resulting two-beam product mean value is then repeated by setting one detector at different optical wavelengths to obtain a crossed-beam spectrum. The physical interpretation of these spectra then permits an analysis of the optical and thermodynamic properties inside a region already selected by triangulation and statistical correlation methods. This general concept of crossed-beam spectroscopy is illustrated for a statistical band model of pressure-broadened lines. The analytical formulation indicates that, with the proper choice of only two wavelengths, the mean absorption may be obtained as well as the local mean temperature and partial pressure. Author

N68-18139 Joint Publications Research Service, Washington, D. C.
SUPERSONIC FLOW AROUND BLUNT CONFIGURATIONS

21 Feb. 1968 19 p refs Transl. into ENGLISH from Zh. Vychislitel'noi Mat. i Mat. Fiz. (Moscow), v. 6, no. 1 and 4, 1966, v. 7, 1967
(JPRS-44459) CFSTI: $3.00

CONTENTS:

1. NUMERICAL DEFINITION OF THE SUPERSONIC FLOW OF A VISCOUS GAS AROUND A BLUNT BODY A. I. Tolstykh p 1–11 refs (See N68-18140 08-12)

2. SUPERSONIC FLOW OF A GAS AROUND A BLUNT-NOSED CONE TAKING RADIATION INTO ACCOUNT p 12–18 refs (See N68-18141 08-12)

N68-18140 Joint Publications Research Service, Washington, D. C.

NUMERICAL DEFINITION OF THE SUPERSONIC FLOW OF A VISCOUS GAS AROUND A BLUNT BODY

A. I. Tolstykh *In its* Supersonic Flow Around Blunt Configurations 21 Feb. 1968 p 1–11 refs (See N68-18139 08-12)

In the present report we give a brief description of a method for calculating the viscous flow in the area of blunting with the aid of equations that differ from Navier-Stokes equations chiefly by the lower order of the old derivatives in respect to the coordinate along the surface of the body. These equations have been solved by integral relationships. Author

N68-18141 Joint Publications Research Service, Washington, D. C.

SUPERSONIC FLOW OF A GAS AROUND A BLUNT NOSED CONE TAKING RADIATION INTO ACCOUNT

In its Supersonic Flow Around Blunt Configurations 21 Feb. 1968 p 12–18 refs (See N68-18139 08-12)

In the present report, we are considering the solution of the problem concerning the flow around the lateral surface of a cone, having spherical blunting by a supersonic flow of radiating gas. The solution is obtained by the method of characteristics. The equations of discontinuity, motion, energy, state and relationship for determining the energy losses per unit of volume of gas per time unit owing to radiation are used. Author

N68-18146*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPUTER PROGRAM FOR CALCULATING ISOTHERMAL, TURBULENT JET MIXING OF TWO GASES

Leo F. Donovan and Carroll A. Todd Washington Mar. 1968 42 p refs
(NASA-TN-D-4378) CFSTI: HC $3.00/MF $0.65 CSCL 20D

This report describes a computer program for solving a simplified model of the turbulent mixing that occurs between a central fuel jet and a surrounding, faster-moving coaxial stream of propellant. As such, this report constitutes a step toward a better understanding of this aspect of the gas-core nuclear rocket. Local values of time-averaged velocity and the mass fraction of fuel can be calculated for a reactor in less isothermal a minute on the IBM 7094. The von Mises transformation was used to convert the axisymmetric forms of the isothermal boundary layer momentum and diffusion equations to forms amenable to numerical solution. The effects of confining walls were not considered. The program can solve problems in which the initial velocities and densities of the two streams differ greatly, by using expressions for eddy viscosity that vary radially as well as axially. The effects of initial coaxial-stream- to jet-velocity and density ratios on velocity and mass fraction profiles are shown. An unspecified reference density occurs in the eddy viscosity formulation; the influences on velocity and mass fraction profiles of several choices for the reference density are illustrated. Radial and axial variations of eddy viscosity and the product of density and eddy viscosity are also given. Estimates are made of the effects of initial velocity ratio and initial density ratio on the mass of the major jet component contained within a given volume. The maximum and minimum amounts that could be present are included for comparison. Author

N68-18168# France. Ministere de l'Air, Paris.

VORTEX DECOMPOSITION OF A LAMINAR WAKE [DECOMPOSITION TOURBILLONNAIRE D'UN SILLAGE LAMINAIRE]

Brian Quinn Serv. de Doc. Sci. et Tech. de l'Armament 1966 53 p refs In FRENCH *Its* Publ. Sci. et Tech. No. 426

Periodic formation of vortices in the wake of an obstacle with laminar boundary layer was investigated, particularly in terms of the frequency of such formations. Classical theories of stability are reviewed, and attention is given to both experimental and analytical studies. Wind tunnel studies are reported for the vortex decomposition, and a formula is presented for the determination of frequency as a function of the properties of the fluid and the geometry of the obstacle. Evidence is given for a relationship between the drag coefficient and the Strouhal number. Transl. by M.W.R.

N68-18204# Technion Research and Development Foundation, Ltd., Haifa (Israel). Dept. of Aeronautical Engineering.

ON THE APPLICATION OF INTEGRAL METHODS IN SEPARATED FLOWS Scientific Interim Report No. 4

Arnan Seginger and Josef Rom Oct. 1967 21 p refs
(Contract F61052-67-C-0033)
(TAE-77; ARL-68-0016; AD-663539)

It is shown that the mixing function used in the integral method of Crocco and Lees implies the assumption of similarity of the flow field. As the separated flow is non similar, application of this formulation to the complete flow field is not permissible. Such an application leads to erroneous results. Good agreement with experimental results, previously obtained by modifications of the Crocco-Lees method, is shown to be due to the division of the separated flow region into distinct zones where, in each of these zones, the flow can be assumed to be consistent with a certain similar solution. The singularity at the critical point of the Crocco-Lees method is shown to be obtained by the application of the integral equations over the complete separated region disregarding the similarity restrictions. Some questions are raised concerning the validity of the application of the integral of the first moment of the momentum equation over the complete separated region. It seems that a re-evaluation of the formulation of the equations applicable to separated flow analysis is required. Author (TAB)

N68-18253*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

PRESSURE AND HEAT TRANSFER ON BLUNT CURVED PLATES WITH CONCAVE AND CONVEX SURFACES IN HYPERSONIC FLOW

Davis H. Crawford Washington Mar. 1968 59 p refs
(NASA-TN-D-4367) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Pressure and heat transfer have been measured in the presence of both favorable and adverse pressure gradients at Mach numbers of 6.8 and 9.6 and Reynolds numbers based on length from 0.5×10^6 to 3.0×10^6. The pressure data were represented by a power law relationship, and the empirical constants from this relationship were used to calculate the heat transfer by a simplified method. This method allows similar compressible solutions of the laminar boundary layer with pressure gradient to be directly applied without the use of integral or iterative methods. The results of these calculations are compared with the experimental values and with the calculated results from a more complex laminar similarity method requiring a machine program and iterative procedures. Differences between the two theoretical methods are shown to be slight for many applications. Applications where the simple method is less accurate are defined. Author

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N68-17243# Weapons Research Establishment, Salisbury (Australia).

THE RADIANT OUTPUT OF GRENADE GLOW CLOUDS IN THE LOWER THERMOSPHERE

E. R. Johnson, K. H. Lloyd, C. H. Low, and L. M. Sheppard Jun. 1967 30 p refs

(WRE-HSA-23)

Records of the behaviour of aluminised grenade glow clouds at twilight and at night were obtained using cameras and photometers. From these records, the radiance, radiant power and radiant energy have been deduced for the altitude range 100 km to 200 km. The twilight observations show that the absorption cross-section of aluminium monoxide is about 3×10^{-14} cm^2. From the night-time results it is concluded that the glow probably arises from a chemiluminescent reaction with atomic oxygen. Author

N68-17249# Weapons Research Establishment, Salisbury (Australia).

A COMPUTER PROGRAMME TO ASSIST IN THE REDUCTION OF SATELLITE IONOSPHERIC OBSERVATIONS

J. B. Haseler and D. G. Singleton Jul. 1966 28 p refs

(WRE-TN-APD-4)

The availability of satellite scintillation data obtained by the simultaneous observation of the Beacon Explorer satellites at a number of sites throughout Australasia, makes it possible to study the spatial morphology of the F-layer irregularity patches believed to be responsible for the scintillations. A computer program is described which, with such a study in mind, produces annotated data for further analysis, together with a convenient cartographic display of the data. The maps so produced may provide useful data on the geographical distribution, if this is simple and clear cut. In the event that this should be the case, the programme outputs the annotated data on magnetic tape in binary or in binary code digit form so that it may be subjected to more detailed analysis. This tape will also serve as a convenient starting point for analyses aimed at investigating areas of the scintillation problem other than that of spatial distribution. Author

N68-17316*# California Univ., Berkeley. Lawrence Radiation Lab.

TREATISE IN ORGANIC GEOCHEMISTRY

Eugene Desmond McCarthy (Ph.D. Thesis) Aug. 1967 290 p refs

(Grant NsG-101-61; Contract W-7405-ENG-48)

(NASA-CR-93111; UCRL-17758) CFSTI: HC $3.00/MF $0.65 CSCL 08D

Major problems in organic geochemistry and their relation to the more fundamental scientific questions of chemical evolution and the origin of life were studied. In the experimental approach adopted in this treatise, almost all of the analytical techniques of modern organic chemistry have been utilised in the structural identification of the organic components isolated from a series of crude oils and sediments. Since the major part of the work has concentrated on the hydrocarbons, there has been a particular emphasis on capillary gas chromatography and mass spectrometry. The recent introduction of a combined gas chromatograph–mass spectrometer suggests that this instrument will be the most powerful analytical technique available to organic geochemists. Author

N68-17332*# National Aeronautics and Space Administration, Goddard Space Flight Center.

POLARIZATION MEASUREMENTS OF THE FAR ULTRAVIOLET DAY AIRGLOW

Donald F. Heath Jan. 1968 23 p refs

(NASA-TM-X-63108; X-622-68-31) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The intensity and polarization of the OI, 1304 Å and 1355 Å multiplets and the Vegard–Kaplan System of N_2 have been measured in the dayglow up to 200 km at 90° to the incident solar radiation. No polarization was observed. The lack of observed polarization of OI, 1355 Å and the N_2, Vegard–Kaplan system is proof of collisional excitation. Comparison of the observed intensities of OI, 1355 Å and the N_2 VK system with recent theoretical predictions for photoelectron excitation show excellent agreement for OI but the N_2 VK emission is 10 times weaker than predicted. The volume emission rate of N_2 VK is observed to follow the N_2 density above 165 km. Author

N68-17333# International Training Centre for Aerial Survey, Delft (Netherlands).

PHOTO-INTERPRETATION APPLIED TO A SOIL SURVEY IN WEST CENTRAL LUXEMBURG

P. R. L. Tytherleigh (M.S. Thesis) 1967 61 p refs *Its* Ser. B No. 43/44

This publication describes some photo-interpretation techniques used for aerial photo-interpretation in soil surveys, and a soil survey carried out in a region in west-central Luxemburg, using some of the techniques. It is condensed from a thesis written by the author in partial fulfilment of the requirements for the degree of M.Sc. (Soil Survey). The final photo-interpretation map was completed in May, 1964 and field work was carried out from mid-May till mid-September. The soil map was completed in December 1964. Author

N68-17339 Royal Greenwich Observatory, Herstmonceux (England).

ANNUAL VALUES OF GEOMAGNETIC ELEMENTS SINCE 1941

London HMSO 1967 185 p refs *Its* Bull. No. 134

HMSO: £1 15s

Mean values of the seven geomagnetic elements are given, where known, from all magnetic observatories for the years 1941–1965. Author

N68-17373*# Oregon Univ., Eugene. Center for Volcanology.

AN INVESTIGATION OF VOLCANIC DEPRESSIONS. PART 1: GEOLOGIC AND GEOPHYSICAL FEATURES OF CALDERAS Progress Report

Howel Williams and Alexander R. McBirney 22 Jan. 1968 90 p refs

(Grant NGR-38-033-012)

(NASA-CR-93188) CFSTI: HC $3.00/MF $0.65 CSCL 08G

The three principal groups of calderas are classified, based on the relative amounts of lava and pyroclastic ejecta involved in their formation. These are: calderas associated with voluminous explosive eruptions of siliceous magma, those associated with effusive eruptions of basaltic magma, and those associated with mixed eruptions from ring fractures. Each group is subdivided into several types, and the worldwide distribution, geological data, and manner of origination of each type are discussed. The lithologic variations, compositions, and volumes of pyroclastic ejecta are examined with respect to specific calderas, and gravitational anomalies associated with them are tabulated. Major volcano–tectonic depressions are also described in terms of their geological makeup and history. E.J.S.

N68-17526# Joint Publications Research Service, Washington, D. C.
SOVIET-BLOCK RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NUMBER 173
2 Feb 1968 80 p refs
(JPRS-44234) CFSTI: HC$3.00/MF$0.65

CONTENTS:
1. ASTRONOMY p 1–10 refs (See N68-17527 08-30)
2. METEOROLOGY p 11–16 refs (See N68-17528 08-20)
3. OCEANOGRAPHY p 17–20 refs (See N68-17529 08-13)
4. TERRESTRIAL GEOPHYSICS p 21–41 refs (See N68-17530 08-13)
5. UPPER ATMOSPHERE AND SPACE RESEARCH p 42–65 refs (See N68-17531 08-13)

N68-17529# Joint Publications Research Service, Washington, D. C.
OCEANOGRAPHY
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 173 2 Feb. 1968 p 17–20 refs (See N68-17526 08-13)

Continuing research is briefly reviewed. Seismic data on oceanic and continental crusts, and determination of ice floe size distribution are reported, and the efficiency of monolayers for reducing evaporation is mentioned. Fish research in the Sea of Japan, and underwater living and exploration in a double-sphere underwater laboratory are described. N.E.N.

N68-17530# Joint Publications Research Service, Washington, D. C.
TERRESTRIAL GEOPHYSICS
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 173 2 Feb. 1968 p 21–41 refs (See N68-17526 08-13)

Abstracted data and news briefs are presented on research in geology and terrestrial geophysics. Among the topics covered are the following: seismology and seismic activity; geomagnetic and gravitational intensities and variations; gravimetric measurements; geologic structure, crust and upper mantle studies, and high temperature and pressure properties of meimechite and basalt; electromagnetic induction, thermal energy, and currents in the earth; meteoritic properties; and piezoelectric methods for locating quartz veins. N.E.N.

N68-17531# Joint Publications Research Service.
UPPER ATMOSPHERE AND SPACE RESEARCH
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 173 2 Feb. 1968 p 42–65 refs (See N68-17526 08-13)

Summarized data are presented on investigations of the upper atmosphere and interplanetary space. Reports are given on the following topics: radio wave propagation, reflection, and absorption; gamma rays, X-rays, and cosmic rays in interplanetary space and the atmosphere, and their variations; F_2 and E_s layer structure; atmosphere currents; jet streams, and noctilucent clouds; sky brightness; interplanetary magnetic fields; space biology; and international cooperation in exploration and use of space. N.E.N.

N68-17533# Defence Research Board, Ottawa (Ontario).
CONCERNING REVERSALS AND ORIGIN OF THE GEOMAGNETIC FIELD
Alexandre Dauvillier Jan. 1968 5 p refs Transl. into ENGLISH from Compt. Rend. Acad. Sci. (Paris), ser. B, v. 263, 26 Sep. 1966 p 779–783
(T-4-F)

A discussion is given to show that the phenomenon of geomagnetism is not attributed to internal causes but to causes external to the earth and in fact of solar origin. Thus it becomes a problem not of geophysics but of space physics. Different views based on literature researches in the area of geomagnetic reversals are discussed in relation to a solid inner terrestrial core in equilibrium, reversals attributed to the sun, the magnetic energy of the terrestrial globe, and solar jets that could reverse the geomagnetic field. Three mechanisms are discussed that may account for the magnetic reversals, in the earths geomagnetic field along with the stratigraphic dating of the nine reversals during the last three megayears. B.S.D.

N68-17534# Defence Research Board, Ottawa (Ontario).
GEOTHERMAL PROFILE ACROSS THE CISCARPATHIAN FRONTAL DOWNWARP
R. I. Kutas Feb. 1968 4 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk Ukr. RSR (Kiev), no. 10, 1964 p 1314–1317
(T-4-Ukr.)

To construct this profile, temperatures were logged with an electric thermometer in boreholes, and point-measurements made with a mercury thermometer. A figure is given on the schematic geothermal profile across the Ciscarpathian frontal downwarp, which shows the varying thermal conditions across the terrain of the downwarp. In analyzing what produces this uneven distribution of temperatures, mathematical relationships are given which describe the thermal regime in the upper part of the earth's crust, the distribution and intensity of the thermal sources, and conditions of heat transmission from the depths. The geothermal cross-section of the Ciscarpathian frontal downwarp is considered as bistratiate, with low-conductivity layer of tertiary clay sands, and an underlying layer of high-conductivity rocks. Equation for the distribution of temperatures in a two-layered medium heated by thermal flux is included along with an electro-thermal analog method for temperature distribution in a nonhomogeneous medium. B.S.D.

N68-17595*# Globe Exploration Co., Inc., El Paso, Tex. Advanced Projects Div.
ERROR PROPAGATION IN THE ROCKET GRENADE EXPERIMENT
Dan J. Ramsdale 15 Jan. 1968 46 p refs
(Contract NAS5-9583)
(NASA-CR-93209) CFSTI: HC$3.00/MF$0.65 CSCL 04A

The method of determining the standard error present in the calculated values of temperature and winds in the layer between grenade pairs is explained. After reviewing the ray tracing procedure used in the NASA rocket-grenade experiment, the sources of error in the experiment are enumerated and classified as either uncertainties in experimental measurement or approximations in theoretical development. The computed temperature and winds are assumed to be in error due to the uncertainty in reading the break times of the wave as it crosses each microphone in the array, and the deviation of the layered model atmosphere from the true atmosphere. The latter is regarded as a systematic error which can be removed by a suitable shift in grenade coordinates. An approximate method for propagating the surface standard errors to yield standard errors in the computed temperature and winds is discussed. Standard methods of error propagation theory are used to derive a lengthy set of mathematical expressions which facilitate the calculation of the required standard errors in temperature and winds. The expressions were incorporated into the existing computer program. Results indicate that this method of error analysis is valid. R.N.A.

N68-17597 Joint Publications Research Service, Washington, D. C.
SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NUMBER 174

19 Feb. 1968 195 p refs Transl. into ENGLISH from Russian (JPRS-44416) CFSTI: $3.00

CONTENTS:

1. ASTRONOMY p 1–20 (See N68-17598 08-30)
2. METEOROLOGY p 21–32 (See N68-17599 08-20)
3. OCEANOGRAPHY p 33–37 (See N68-17600 08-13)
4. TERRESTRIAL GEOPHYSICS p 38–66 (See N68-17601 08-13)
5. UPPER ATMOSPHERE AND SPACE RESEARCH p 67–94 (See N68-17602 08-13)
6. SOVIET GEOPHYSICS ON THE FIFTIETH ANNIVERSARY OF THE GREAT OCTOBER REVOLUTION Yu. V. Riznichenko p 95–109 (See N68-17603 08-13)
7. PRINCIPAL ATTAINMENTS AND APPROACHES IN DEVELOPMENT OF STUDY OF PHYSICS OF THE EARTH V. A. Magnitsky p 110–119 refs (See N68-17604 08-13)
8. RESULTS AND TASKS OF SOVIET SEISMOLOGY (1917–1967) Ye. F. Savarenskiy p 120–139 (See N68-17605 08-13)
9. EXPLORATORY GEOPHYSICS IN THE USSR DURING THE YEARS OF SOVIET RULE (1917–1967) V. V. Fedynskiy p 140–172 (See N68-17606 08-13)
10. DEVELOPMENT OF SEISMIC PROSPECTING METHODS IN THE USSR N. N. Puzyrev p 173–185 (See N68-17607 08-13)

N68-17600 Joint Publications Research Service, Washington, D. C.

OCEANOGRAPHY

In its Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 33–37 (See N68-17597 08-13)

Investigations on ocean currents, compositions, and surveys are briefly reported. Among the studies included are the following: transfer of wind energy to water waves; vertical circulation and oxygen minimum layer formation in the Atlantic Ocean; eddy currents; fluctuation of audio signals scattered by the ocean bottom; and hydrographic and hydrochemical surveys of the Soviet–Cuban expedition. N.E.N.

N68-17601 Joint Publications Research Service, Washington, D. C.

TERRESTRIAL GEOPHYSICS

In its Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 38–66 Transl. into ENGLISH from TASS Rept. Moscow, Izv., 14 Jan. 1968 p 4 (See N68-17597 08-13)

Summarized data are presented on continuing research. Among the topics covered are the following: earthquake characteristics, seismic maps, and seismic signal recording; elastic properties of rock masses, crust structure, and bedrock relief of permafrost regions; geologic surveys in shallow water areas; and earth oscillations and geomagnetic pulsations. N.E.N.

N68-17602 Joint Publications Research Service, Washington, D. C.

UPPER ATMOSPHERE AND SPACE RESEARCH

In its Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 67–94 (See N68-17597 08-13)

Abstracted data are presented on atmospheric and space investigations, and problems connected with space exploration. Emphasis is placed on studies of the ionosphere and its drift, scattering, absorption, inhomogeneities, and structure. Other topics covered include the following: cosmic ray showers, intensities, and composition; solar flares, solar wind, and solar emissions; meteors and meteor trails; heat exchangers for spacecraft, and future spacecraft design. N.E.N.

N68-17603# Joint Publications Research Service, Washington, D. C.

SOVIET GEOPHYSICS ON THE FIFTIETH ANNIVERSARY OF THE GREAT OCTOBER REVOLUTION

Yu. V. Riznichenko *In its* Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 95–109 Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Zemli (Moscow), no. 11, Nov. 1967 p 3–12 (See N68-17597 08-13)

The early development, progress, and achievements in geologic investigations of the last 50 years are reviewed. Emphasis is placed throughout on the multidisciplinary aspects, beginning with the studies made in the area of the Kursk magnetic anomaly. The contributions of the Soviet scientists in both experimental and theoretical aspects are summarized, and are centered primarily in the fields of seismology and seismic prospecting, magnetometry and gravimetry, and telluric currents and thermal energy. The growing international cooperation of the last decade is described. An outline is given of the transition from a study of general properties and qualitative description to a quantitative evaluation, and then theoretical models of the earth's structure. N.E.N.

N68-17604# Joint Publications Research Service, Washington, D. C.

PRINCIPAL ATTAINMENTS AND APPROACHES IN DEVELOPMENT OF STUDY OF PHYSICS OF THE EARTH

V. A. Magnitsky *In its* Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 110–119 refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Zemli (Moscow), no. 11, Nov. 1967 p 13–18 (See N68-17597 08-13)

An outline is presented on the developments and contributions of Soviet geologic activity during the past fifty years. The investigations are traced from the early emphasis on seismological aspects and the mechanical properties of the earth's crust, to studies of the earth's density and core viscosity. Later the stress was on deep layer temperatures, and investigations of the thermal energy and thermal history of the earth. In conjunction with the studies of the interior, high temperature and high pressure experiments were undertaken. A bibliography is included. N.E.N.

N68-17605 Joint Publications Research Service, Washington, D. C.

RESULTS AND TASKS OF SOVIET SEISMOLOGY (1917–1967)

Ye. F. Savarenskiy *In its* Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 120–139 Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Zemli (Moscow), no. 11, Nov. 1967 p 28–40 (See N68-17597 08-13)

The history of Soviet seismologic investigations is presented. The early theories and experiments are mentioned, and the developments which took place after the Great October Revolution are emphasized. Applications of seismic studies, such as in planning railroads in earthquake areas and in prospecting, are reviewed. The establishment of a network of observation stations is described. Methods for predicting earthquakes and tsunami are summarized, and the necessity of building structures able to withstand severe earthquakes is stressed. N.E.N.

N68-17606 Joint Publications Research Service, Washington, D. C.

EXPLORATORY GEOPHYSICS IN THE USSR DURING THE YEARS OF SOVIET RULE (1917–1967)

V. V. Fedynskiy *In its* Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 140–172 Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Zemli (Moscow), no. 11, Nov. 1967 p 90–112 (See N68-17597 08-13)

The history of the development of exploratory geology is described, emphasizing applications to the national economy. Stress is placed on the use of seismology in the petroleum industry, and prospecting for minerals is described. Improvements in making geophysical instruments are mentioned, and the most important tasks to be undertaken in the near future are identified. N.E.N.

N68-17607 Joint Publications Research Service, Washington, D. C.

DEVELOPMENT OF SEISMIC PROSPECTING METHODS IN THE USSR

N. N. Puzyrev *In its* Soviet-Bloc. Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 173–185 Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Fiz. Zemli (Moscow), no. 11, Nov. 1967 p 113–121 (See N68-17597 08-13)

A brief history of the use of dynamic wave characteristics for prospecting purposes is presented. The refracted and reflected wave methods are identified as the most important, and development of increasingly sensitive intruments for signal measurement is mentioned. Locating petroleum fields is emphasized, and mineral prospecting is covered. The development of dynamic theories of wave propagation through different geological media is outlined, and the use of seismic waves in investigations of structural geology is described. N.E.N.

N68-17630# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).

COMPUTER PROGRAM FOR TRANSFORMATION OF GEOGRAPHIC COORDINATES INTO GEOMAGNETIC COORDINATES B.L. [PROGRAMME DE TRANSFORMATION DE COORDONNEES GEOGRAPHIQUES EN COORDONNEES GEOMAGNETIQUES B.L.]

J. Brettes Oct. 1967 20 p refs In FRENCH
(CERTS-NT-01-4) CFSTI: HC $3.00/MF $0.65

A revised computer program is set up to transform geodetic coordinates into magnetic coordinates. ESRO

N68-17659# Naval Research Lab., Washington, D. C.

MEASUREMENT OF SPECTRAL RADIANCE OF THE HORIZON SKY

G. L. Knestrick and J. A. Curcio 4 Dec. 1967 24 p refs
(NRL-6615; AD-663883)

Spectral radiance data were obtained for a rectangular portion of the horizon sky under various weather conditions and at different solar positions. Representative curves were selected from 79 spectral radiance measurements which covered meteorological ranges (at 665 millimicrons) from 10 to 106 km and solar altitudes from -6 to 74 degrees. The north horizon at noon, with a 30 km or greater meteorological range, typically produced a peak spectral radiance of 5 micron w/sq cm-srad-millimicrons. The maximum spectral radiance value obtained in the study was 38 micron w/sq cm-srad-millimicrons for the south horizon in winter. The reciprocal dispersion varied from 1.8 millimicrons/mm at 400 millimicrons to approximately 8 millimicrons/mm at 1000 millimicrons. A mixture of fog and haze produced a spectral radiance curve with two maxima. Author (TAB)

N68-17685# Library of Congress, Washington, D. C. Aerospace Technology Div.

INTEROBS AND THE DETERMINATION OF SATELLITE ALTITUDE DENSITIES

Daniel W. Michaels *In its* Foreign Sci. Bull., Vol. 4, No. 2 Feb. 1968 p 102–114 refs (See N68-17681 08-34)

International observations (Interobs), a Soviet-bloc program concerned with the problem of determining sudden atmospheric density changes on the basis of satellite observations, has reported that variations in the density and behavior of the atmosphere can be determined 48 hours after a solar eruption on the basis of observed changes in a satellite's period. The organizational structure and observational techniques of Interobs are reviewed and evaluated. Author

N68-17694*# Volt Technical Corp., Washington, D. C.

GEOMAGNETIC CONTROL OF IONIZATION'S VERTICAL DRIFT IN THE F-REGION OF THE IONOSPHERE [O GEOMAGNITNOM KONTROLE VERTIKAL NOGO DREYFA IONIZATSII V F-OBLAS-I IONOSFERY]

V. I. Drobzhev 4 Mar. 1968 4 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 8, no. 1, 1968 p 176–177
(Contract NAS5-12487)
(NASA-CR-93285; ST-AI-GM-10678) CFSTI: HC $3.00/MF $0.65 CSCL 04A

This note shows that experiment qualitatively corroborates that the 12-hour electric field component transferred from the dynamo-region may play a specific role in the occurrence of ionization's vertical drift in the F-region of the ionosphere. Author

N68-17769# Lincoln Lab., Mass. Inst. of Tech., Lexington.

LONG-PERIOD SIGNAL PROCESSING RESULTS FOR LARGE APERTURE SEISMIC ARRAY

Jack Capon, Roy J. Greenfield, and Richard T. Lacoss 15 Nov. 1967 81 p refs
(Contract AF 19(628)-5167; ARPA Order 512; Proj. Vela Uniform)
(TN-1967-50; ESD-TR-67-564; AD-663429)

The results of a series of off-line signal processing experiments are presented for long-period data obtained from the Large Aperture Seismic Array (LASA) located in eastern Montana. The signal-to-noise ratio gains obtained with maximum-likelihood processing, as well as other simpler forms of processing, are presented for body-wave as well as surface-wave phases. A discussion of the frequency-wavenumber characteristics of the noise which led to these results is also given. On the basis of these experiments several recommendations are made concerning optimum long-period array configurations and on-line or off-line processing methods. The usefulness of maximum-likelihood processing in suppressing an interfering teleseism is demonstrated. An experiment is given in which maximum-likelihood processing achieved about 20-db suppression of an interfering teleseism, while simpler forms of processing such as beamforming obtained about 11 db. The matched filtering of surface waves using chirp waveforms is also discussed. The most useful discriminant for distinguishing between natural seismic events and underground nuclear explosions, using both the long-period and short-period data, was found to be that based on the relationship between the surface-wave and body-wave magnitudes. Measurements of this discriminant made on events from four tectonic regions of the earth are presented. It is shown that 60, 100 percent detectability of surface waves for natural seismic events from the Central Asian-Kurile Islands-Kamchatka region occurs at about LASA body-wave magnitudes 4.5, 4.9, respectively. Author (TAB)

N68-17771# Stanford Research Inst., Menlo Park, Calif.

THE IMPACTION OF AIRBORNE PARTICLES ON PLATE COLLECTORS

Carl F. Miller Apr. 1967 64 p refs
(Contract N00228-67-C-1143)
(AD-663800)

Impaction data for a plate collector exposed to falling particles that were produced by explosive eruptions of volcano Irazu were correlated, and approximating functions for representing the impaction coefficients of the plates were derived from the data. The arrangement of the plates at 0 (180), 30, 60, 90, 120, and 150 degrees from the horizontal provided four classes of impaction geometries. An approximate relationship between the impaction or collecting efficiency of the plates and the tray collector (or the ground surface) was also derived. The plate collector data were used to estimate the effective average diameter of the falling particles, and, with a few exceptions, this diameter was always greater than the mass median diameter determined from sieve analysis of the particles. Thus it was concluded that, in the majority of the particle showers, the particles fell and impacted as agglomerates of many smaller particles. Author (TAB)

N68-17855# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
LOWER D-REGION ROCKET EXPERIMENTS USING LOW FREQUENCY RADIO WAVE ABSORPTION
E. R. Middendorf 15 Sep. 1967 52 p refs
(Contract F19628-67-C-0301)
(SR-307; AFCRL-67-0560; AD-663711)

A theoretical investigation is made of a possible method for determining electron densities and collision frequencies in the ionospheric D-region. This by means of an experiment involving the simultaneous measurement of the amplitudes of two radio waves of different frequencies, as a function of height, propagated from the ground to a rocket. It is hypothesized that the two frequencies, can be used to recover at each height of interest the two unknown quantities, electron density and collision frequency. It is shown, however, that for any two propagation frequencies below the gyro frequency this method fails. It is shown also that these results are consistent with those that might be obtained using the WKB approximations based on the roots of the Booker quartic. An error analysis of the single frequency method for determining electron densities assuming a single collision frequency model is also presented. Author (TAB)

N68-17858# Danish Meteorological Inst., Copenhagen. Geophysical Section.
IONOSPHERIC RESEARCH USING SATELLITES Progress Report, 1 Sep. 1966–31 Aug. 1967
Asger N. Lundbak and Ib Steen Mikkelsen Bedford, Mass. AFCRL 30 Sep. 1967 8 p
(Contract AF 61(052)-828)
(AFCRL-67-0689; PR-9; AD-663753)

Unmodulated signals from Explorer 22 on 20, 40 and 41 Mc/s have been recorded at two places in Denmark and Greenland. Both Faraday rotation and scintillation phenomena are very frequent in the records, so that ionospheric irregularities and total electron content can be studied in detail. The following progress report presents a review of the activity in this respect from 1 Sep 1966 to 31 Aug 1967. Further, the geostationary satellite Canary Bird is recorded on 136.44 Mc/s during short intervals. Such records of Canary Bird and other geostationary satellites will be strengthened in the future. Author (TAB)

N68-17869# Observatorio del Ebro, Tortosa (Spain).
DAILY AND SEASONAL VARIATION OF THE TOTAL ELECTRON CONTENT OF THE IONOSPHERE OVER TORTOSA Scientific Report, 1 Mar. 1966–30 Mar. 1967
S. I. Galdon Eduardo Bedford, Mass. AFCRL 2 Apr. 1967 29 p refs
(Contract AF 61(052)-924)
(AFCRL-67-0682; SR-1; AD-663441)

The Total Electron Content of the Ionosphere can be calculated from the Faraday fadings of signals received from Satellites. After an indication of the method used at TORTOSA, exposure is made of the results obtained at the Station with the records of the S - 66 Satellite from November 1964 till February 1966. Consideration is given to the diurnal and seasonal variation of T.E.C. and results are compared with those gathered by other authors. TAB

N68-17920# Harvard Univ., Cambridge, Mass. Lab. for Computer Graphics.
ENERGY FLOW AND SPATIAL ORDER, WITH SPECIAL REFERENCE TO MIXED HEXAGONAL CENTRAL PLACE HIERARCHIES
Michael J. Woldenberg 3 Jan. 1968 47 p refs *Its* "Geography and the Properties of Surfaces" Ser. Paper no. 8
(Contract N00014-67-A-0298-0004)
(ONR-TR-8; AD-663910)

This paper is a major revision of Harvard Theoretical Geography Paper No. 5. The number of market areas (cumulated number of towns) for each order in a central place hierarchy is predicted. Given an array of numbers corresponding to geometric series to the bases 3, 4, and 7, the number of market areas depends on both the cut off point in the array, and the number of orders required. Given these constraints, the geometric means of the groupings required to create orders should approximate a geometric progression. The expected number of market areas is the convergence of the arithmetic and geometric means of the groups. This equilibrium balances opposing tendencies for minimum overland work and maximum work savings on economies of scale. In addition, the entropy of the system approaches the maximum possible. Six empirical studies show correspondence to this model, even though the investigators were operating without knowledge of the model, and used different methods to detect hierarchy. Further applications of this model in geomorphology, ecology, physiology, and botany are suggested. Author (TAB)

N68-17962*# Boeing Scientific Research Labs., Seattle, Wash. Geo-Astrophysics Lab.
VHF REFRACTION AND SCATTERING BY VISIBLE AURORAL FORMS
E. J. Fremouw (Stanford Res. Inst., Menlo Park, Calif.) and J. M. Lansinger Sep. 1967 21 p refs Prepared jointly with Stanford Res. Inst., Menlo Park, Calif. and Alaska Univ.
(Contract NAS5-3940)
(NASA-CR-91264; D1-82-0654; AD-663663) CSCL 04A

Two relatively new techniques, one analytical and one observational, have been applied to the problem of differential phase shifting of radio waves by the aurora. The radio measurements used were interferometer observations of cassiopeia a. The analytical technique consists of computing the Kirchhoff-Fresnel Diffraction integral for models of wavefront perturbation produced in the ionosphere, the results being compared in detail with interferometer records of isolated refraction events. All-sky-camera and photometer records show many of these events to be directly related to passage of auroral forms through the radio line of sight. Random-tracking antennas, providing movies of the aurora with a time resolution of 100 milliseconds and comprising the new observational technique. Author (TAB)

N68-17967# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.
CONJUGATE POINT SYMPOSIUM, VOLUME 2, SESSION 3
Jul. 1967 247 p refs Symp. held on Boulder, Colo. 13–16 Jun. 1967
(IERTM-ITSA-72)

CONTENTS:

1. RAPID GEOMAGNETIC FIELD VARIATIONS OBSERVED AT CONJUGATE LOCATIONS W. H. Campbell 28 p refs (See N68-17968 08-13)

2. Pi EVENTS J. A. Jacobs (British Columbia Univ.) 24 p refs (See N68-17969 08-13)

3. CONJUGATE OBSERVATIONS OF THE pi 1 MICROPULSATION EVENT OF MAY 25, 1964 R. G. Green 4 p (See N68-17970 08-13)

4. RELATION OF CORRELATED MAGNETIC MICROPULSATIONS AND ELECTRON PRECIPITATION TO THE AURORAL SUBSTORM R. L. McPherron, G. K. Parks, and F. Coroniti (Calif. Univ.) 17 p refs (See N68-17971 08-13)

5. FREQUENCY ANALYSIS OF THE GEOMAGNETIC MICROPULSATIONS OBSERVED AT THE MAGNETIC EQUATOR Y. Kato (Tohoku Univ.) 13 p refs (See N68-17972 08-13)

6. SIMULTANEITY OF Pc 3 MICROPULSATIONS AT CONJUGATE POINTS A. C. Fraser-Smith (Lockheed Missiles and Space Co.) 8 p refs (See N68-17973 08-13)

7. THE BEHAVIOR OF MAGNETOSPHERIC PROTON DENSITIES DERIVED FROM PEARL DISPERSION MEASUREMENTS H. B. Liemohn, J. F. Kenney, and H. B. Knaflich (Boeing Scientific Res. Labs.) 3 p (See N68-17974 08-13)

8. RECENT INVESTIGATION ON HYDROMAGNETIC EMISSIONS T. Watanabe (British Columbia Univ.) 17 p refs (See N68-17975 08-13)

9. DIFFUSION PROCESSES INFLUENCED BY CONJUGATE-POINT WAVE PHENOMENA J. M. Cornwall (Aerospace Corp.) 19 p refs (See N68-17976 08-13)

10. MEASUREMENT AND INTERPRETATION OF ULF AND VLF POWER SPECTRA J. F. Kenney, H. B. Knaflich, and H. B. Liemohn (Boeing Scientific Res. Labs.) 5 p ref (See N68-17977 08-13)

11. EM AND HM GUIDED WAVES IN THE EARTH'S ATMOSPHERE N. Brice (Cornell Univ.) 27 p refs (See N68-17978 08-13)

12. POLAR EMISSIONS L. Owren (Dartmouth Coll.) 11 p refs (See N68-17979 08-13)

13. RECENT RESEARCH ON THE MAGNETOSPHERIC PLASMAPAUSE D. L. Carpenter (Stanford Univ.) 24 p refs (See N68-17980 08-13)

14. WHISTLER PROPAGATION IN MAGNETOSPHERIC DUCTS R. L. Smith and J. J. Angerami (Stanford Univ.) 9 p (See N68-17981 08-13)

15. CONJUGATE HF DUCTING J. A. Thomas (Melbourne Univ.) 7 p refs (See N68-17982 08-13)

16. MEDIUM-FREQUENCY CONJUGATE ECHOES OBSERVED ON TOPSIDE-SOUNDER DATA D. B. Muldrew (Defence Res. Telecomm. Establ.) 15 p refs (See N68-17983 08-13)

17. PROPAGATION CHARACTERISTICS OF THE EQUATORIAL IONOSPHERE AS MEASURED BETWEEN MAGNETICALLY CONJUGATE POINTS AT VHF E. D. Bowen (Smyth Res. Asso.) 4 p (See N68-17984 08-13)

N68-17968# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

RAPID GEOMAGNETIC FIELD VARIATIONS OBSERVED AT CONJUGATE LOCATIONS

W. H. Campbell *In its* Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 28 p refs (See N68-17967 08-13)
(Grant NSF GA-147; ARPA Order 183)

This paper reviews the observed evidence for the earth field-line dependence of rapid geomagnetic field variations in the frequency range from 4.0 to 0.002 c/s. The topics are presented in the recommended order of the pi and pc system for naming field fluctuations, using *i* to indicate an irregular pattern and *c* a regular, mainly continuous appearance of the amplitude trace. The pi is given first, followed by the pc, proceeding from lower to higher frequencies. Emphasized are characteristics of the micropulsations that were observed simultaneously at comparable earth field locations in opposite hemispheres. Station locations of the observers whose work is discussed are summarized in a table. Focus is on the phenomena, and no attempt is made to evaluate priority of first observations. K.W.

N68-17969# British Columbia Univ., Vancouver. Inst. of Earth and Planetary Sciences.

PI EVENTS

J. A. Jacobs *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 24 p refs (See N68-17967 08-13)

Discussed are theories and forms of micropulsations (pi) and the characteristics of pi activities at conjugate points. The subject is arranged in categories pi 1 (periods 1–40 sec.) and pi 2 (periods 40–150 sec.). Frequency spectra, the role of the Kp index, polarization, and source mechanisms of pi 2 events are briefly treated, and pi activities at the Great Whale River and the Byrd Station are described. K.W.

N68-17970# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

CONJUGATE OBSERVATIONS OF THE pi 1 MICROPULSATION EVENT OF MAY 25, 1964

R. G. Green *In its* Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 4 p (See N68-17967 08-13)

This is a brief account of an IQSY event that probably originated with the 108 MHz burst of May $21^{d}11^{h}46^{m}$ U.T. Conjugate ulf pulsations of irregular amplitude and period (1–40) sec) were recorded as a micropulsation storm at Baie St. Paul, Quebec, and Eights, Antarctica, for several hours on May 25. These stations comprise a pair very near to the exact computed conjugacy (L=4.0) as well as being very close to each other in local time (U.T.–5^{h}). It is the purpose of this paper to show the nature of conjugacy between this pair of stations. Comparisons of dynamic micropulsation spectra, simultaneous amplitude spectra, and concurrent cosmic noise absorption are given. Author

N68-17971# California Univ., Berkeley. Space Sciences Lab.

RELATION OF CORRELATED MAGNETIC MICROPULSATIONS AND ELECTRON PRECIPITATION TO THE AURORAL SUBSTORM

R. L. McPherron, G. K. Parks, and F. Coroniti *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 17 p refs (See N68-17967 08-13)

Data recorded simultaneously in the auroral zone are used to characterize distinct types of pulsation and precipitation phenomena. It is found that certain types of pulsation and precipitation are invariably associated with each other. Further, these phenomena occur only in certain limited regions of local time and are always associated with an auroral substorm. Correlated phenomena include: (1) Local Time (LT) 2200–0200, micropulsation noise bursts and impulsive electrons, associated with auroral breakup and sudden changes in auroral electrojet; (2) LT 0200–1000, band limited irregular pulsations and modulated electrons, associated with diffuse, patchy aurora and negative bays; (3) LT 1000–1500, quasi-sinusoidal pulsations and modulated electrons, associated with large amplitude dayside magnetic disturbances occurring during auroral substorms; (4) LT 1400–1500, magnetic impulses and microburst electrons, associated with dayside substorm disturbances; and (5) LT 1500–2200, micropulsation sweepers and pre-midnight pulsations, associated with no type of structured electron precipitation, but occurring only during auroral substorms. Evidence substantiating the correlation is given which suggests a causal relation between modulated electron precipitation and associated micropulsation types, with micropulsations playing the more fundamental role. K.W.

N68-17972# Tohoku Univ., Sendai (Japan). Geophysical Inst.

FREQUENCY ANALYSIS OF THE GEOMAGNETIC MICROPULSATIONS OBSERVED AT THE MAGNETIC EQUATOR

Yoshio Kato *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 13 p refs (See N68-17967 08-13)

Magnetic micropulsations were observed at Huancayo, Peru, located near the magnetic equator. The observed power spectra of the micropulsations at the magnetic equator are compared with those of Maui Island, Hawaii, and Onagawa, Japan, in the middle latitude. The same magnetic micropulsations are also compared with the theoretical power spectra resulting from the work of other investigators. The mechanism of pi 2 events is briefly discussed based on the power spectrum data. Sample recordings of the frequency analyses of pi 2, reproduced through several bandpass filters, are presented. K.W.

N68-17973# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.

SIMULTANEITY OF PC 3 MICROPULSATIONS AT CONJUGATE POINTS

A. C. Fraser-Smith *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 8 p refs (See N68-17976 08-13)

The small-amplitude data analyzed in this stydy were recorded during 1963 on magnetic tape at the four Pacific geomagnetic

observatories at Palo Alto, Kauai, Canton Island, and Tongatapu. The three island stations are located at approximately the same geomagnetic longitude, and Kauai and Tongatapu are also located at approximately conjugate geomagnetic latitudes. All observatories had identical recording equipment. Identical pc 3 signals were recorded at all four stations, but those at Canton Island, which lies close to the geomagnetic equator, were relatively weak and difficult to compare. The Kauai and Tonga signals were always closely similar to those at Palo Alto, an indication of the significance of conjugacy. Two periods of pc 3 activity were analyzed in detail: August 1–2, 1963, and August 27–28, 1963, when there were approximately seven and nine hours, respectively, of comparable activity. A total of nearly 100 hours of recorded data from the four stations was analyzed. The results presented in this paper mainly concern the two conjugate stations. K.W.

N68-17974# Boeing Scientific Research Labs., Seattle, Wash.
THE BEHAVIOR OF MAGNETOSPHERIC PROTON DENSITIES DERIVED FROM PEARL DISPERSION MEASUREMENTS
H. B. Liemohn, J. F. Kenney, and H. B. Knaflich *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 3 p Submitted for publication (See N68-17967 08-13)

The dispersion characteristics of 116 pc 1 micropulsation pearls are described and analyzed using various models of the magnetosphere. Theoretical analyses have shown that signal dispersion depends primarily on the plasma density distribution along the field line and the geocentric distance measured in earth radii to the place where the field line crosses the equatorial plane. Thus measurements of experimental dispersion can be used to estimate the plasma density at various distances out in the magnetosphere. The geomagnetic field B is assumed to be a dipole so that the field-line paths are given by $R = L \cos^2\lambda$ where λ is the geomagnetic latitude and L is the geocentric distance to the equatorial intercept of the field. The plasma distribution is assumed to have the general form $N = N_0(L)P(L,\lambda)$ where $P(L,0)$ is normalized to unity so that N_0 can be interpreted as the equatorial density distribution. The different assumptions concerning the distribution of plasma along the field line will change the determination of L only a small amount while making a larger change in N_0. Author

N68-17975# British Columbia Univ., Vancouver. Inst. of Earth and Planetary Sciences.
RECENT INVESTIGATION ON HYDROMAGNETIC EMISSIONS
Tomiya Watanabe *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 17 p refs (See N68-17697 08-13)

Hydromagnetic emissions are defined in this paper to include geomagnetic micropulsations with short periods from about 0.2 sec to 5 sec, i.e., all the pc 1^1 type micropulsations as well as some pi 1^1 types. The various types of signals and wave modes in hydromagnetic emissions are discussed. Emphasized are problems in connection with the cyclotron instability process as the triggering mechanism of hydromagnetic emissions. Problems that were encountered by other investigators in the theoretical approach to hydromagnetic emission are briefly reviewed. K.W.

N68-17976# Aerospace Corp., El Segundo, Calif.
DIFFUSION PROCESSES INFLUENCED BY CONJUGATE-POINT WAVE PHENOMENA
John M. Cornwall *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 19 p refs (See N68-17967 08-13)
(Contract AF 04(695)-1001)

Radial diffusion coefficients for low-energy protons in the magnetosphere are estimated for processes involving pc 1, 2, and 3 hydromagnetic waves. These diffusion coefficients are compared to rough estimates of diffusion due to magnetic impulses and bays, to arrive at an overall diffusion rate. An effective loss rate for pitch angle diffusion caused by pc 1 is developed and combined with radial diffusion to yield a nonlinear differential equation. Some estimates of expected proton flux levels are made, on the basis of this equation. Author

N68-17977# Boeing Scientific Research Labs., Seattle, Wash.
MEASUREMENT AND INTERPRETATION OF ULF AND VLF POWER SPECTRA
J. F. Kenney, H. B. Knaflich, and H. B. Liemohn *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 5 p ref (See N68-17967 08-13)

Multi-hop vlf whistler events recorded by a ground receiver and by satellite were analyzed for power spectra by playing a tape loop repeatedly through a swept-frequency filter. Several multi-hop ulf whistlers, also known as pearl micropulsations, were similarily analyzed for power spectra. The relationship between the observed power spectra of successive whistler echoes is outlined. Graphs and ampligrams are shown of multi-hop vlf events, multi-hop ulf whistler events, power ratios, and power transfer curves for the cyclotron resonance interaction between ulf whistlers and nonthermal protons in the magnetosphere. K.W.

N68-17978# Cornell Univ., Ithaca, N. Y. Center for Radiophysics and Space Research.
EM AND HM GUIDED WAVES IN THE EARTH'S ATMOSPHERE
Neil Brice *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 27 p refs (See N68-17967 08-13)
(Grant NSF GA-878)

The guiding of waves in the upper atmosphere and guided waves of natural origin are considered. The general condition for trapping or ducting of waves along a surface is discussed, particularly the guiding of waves due to anisotropy in the propagation which arises from the earth's magnetic field. Treated are origin and characteristics of right-hand polarized (electromagnetic) waves at frequencies between the electron and ion cyclotron frequencies, and left-hand polarized (hydromagnetic) waves at frequencies below the ion cyclotron frequency. Covered in the first group are whistlers and vlf emissions, while the second group includes ion whistlers and micropulsations. K.W.

N68-17979# Dartmouth Coll., Hanover, N. H. Radiophysics Lab.
POLAR EMISSIONS
Leif Owren *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 11 p refs Sponsored by NSF (See N68-17967 08-13)

The natural elf (0.3–3 kHz) and vlf (3–30 kHz) emissions occurring in the polar regions have been observed at Vostok, Antarctica, and Thule (Qanoq), Greenland, since 1964. The stations are located one degree from the South and North Geomagnetic Poles respectively. Recordings were started at Vostok (gm. lat. 89.1°S) in February 1964 and at Thule (gm. lat. 88.9°N) in October 1964. Measurements were also made at Narssarssuaq (gm. lat. 71.2°N) and at Godhavn (gm. lat. 79.9°N). The chain of stations Narssarssuaq, Godhavn, and Thule spans the polar cap region from the auroral zone to the geomagnetic pole at about 9° intervals of geomagnetic latitude within a 40° sector of geomagnetic longitude. The equipment and methods that were employed are described. The observed phenomena include polar chorus, auroral hiss, local hiss events at the geomagnetic poles, the origin of local hiss events, and magnetic storm events during 1965. K.W.

N68-17980# Stanford Univ., Calif. Radioscience Lab.
RECENT RESEARCH ON THE MAGNETOSPHERIC PLASMAPAUSE

D. L. Carpenter *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 24 p refs (See N68-17967 08-13)
(Grants NSF GA-775; NSF GA-214; AF-AFOSR-783-67)

The purpose of this paper is to review some of the features of the plasmapause and to describe a few of the vlf wave phenomena whose characteristics appear to be strongly influenced by the field-aligned boundary. The review of major features includes effects of magnetic activities, plasma motion and the role of substorms, and the effects of the following changes in the plasma medium at the boundary: changes in the tube electron content, field-line distribution of ionization, and equatorial profile of electron density. The wave phenomena affected by the plasmapause is discussed on the basis of satellite observations of a whistler cutoff and vlf noise effects at the boundary, and based on ground observations of propagation from the conjugate hemisphere. K.W.

N68-17981*# Stanford Univ., Calif. Radioscience Lab.
WHISTLER PROPAGATION IN MAGNETOSPHERIC DUCTS
R. L. Smith and J. J. Angerami *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 9 p (See N68-17967 08-13)
(Contract NAS5-2131; Grant NsG-174; NSF GP-948) CSCL 04A

Reviewed are some of the theories of propagation of whistlers in field-aligned ducts and their relation to recent observations. Features of propagation are discussed which were deduced from the ray theory approach and then verified by recent ground and satellite observations. These observations have led to further ray tracing studies which explain some high frequency leakage effects and suggest an indirect experimental determination of duct dimensions and enhancement factors. In addition to ray tracing techniques, the review covers the mode theory of propagation as developed for tropospheric ducting, and the full wave treatment using Maxwell's equations directly. K.W.

N68-17982# Melbourne Univ., Parkville (Australia). Dept. of Physics.
CONJUGATE HF DUCTING
J. A. Thomas *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 7 p refs (See N68-17967 08-13)

A brief discussion is presented of the nature of long delay echoes above the ionosphere attributed to multi-hop ducted propagation between the conjugate reflection levels for the frequencies involved. The detection of these echoes is discussed as verified by the fixed frequency topside sounder Explorer 20 and Alouette 2. K.W.

N68-17983# Defence Research Telecommunications Establishment, Ottawa (Ontario). Radio Physics Lab.
MEDIUM-FREQUENCY CONJUGATE ECHOES OBSERVED ON TOPSIDE-SOUNDER DATA
D. B. Muldrew *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 15 p refs (See N68-17967 08-13)

The results of a statistical study of about 60,000 Alouette 2 equatorial ionograms, of which about 3,000 contain conjugate echoes, are presented in this paper. All available ionograms from eight equatorial stations are classified into five groups, depending on the value of the frequency of the extraordinary wave which has zero refractive index at the satellite height. The data are analyzed, and factors which must be considered in the interpretation of the results are discussed. Examples of ionograms containing conjugate echoes obtained by Alouette 1, Alouette 2, and Explorer 20 are included. K.W.

N68-17984*# Smyth Research Associates, San Diego, Calif.
PROPAGATION CHARACTERISTICS OF THE EQUATORIAL IONOSPHERE AS MEASURED BETWEEN MAGNETICALLY CONJUGATE POINTS AT VHF
E. D. Bowen *In* ESSA Conjugate Point Symp., Vol. 2, Session 3 Jul. 1967 4 p (See N68-17967 08-13) CSCL 04A

A transequatorial propagation experiment was conducted in the Far East in which an anomalous propagation mode appeared. This anomalous mode has been interpreted as a field guided mode as suggested by the experimental evidence. The program was conducted from December 1965 to June 1966. In the experiment, transmissions at 34, 45, 54 and 77 MHz from Okinawa were monitored at receiving sites at Darwin, Australia and at Fiji. The Okinawa–Darwin terminals are very nearly magnetically conjugate and separated by 4300 km. They occupy positions on the same L shell ($L \approx 1.10$), but are separated by about two degrees in latitude. The Okinawa–Fiji path of 7200 km is skewed to about 40° with the magnetic equator. Horizontally polarized yagi antennas were placed three wavelengths above a smooth foreground at each experimental site and at each frequency. Phase locked receivers with narrow tracking loops received the emissions from the stable frequency, 300 Watt, CW transmitters. These transmissions were on occasion pulsed at a 25 cps rate and with a 100 microsecond pulse width for travel time measurements. Author

N68-18012# Arizona Univ., Tucson. Office of Arid Lands Studies
A BIBLIOGRAPHY OF ARID-LANDS BIBLIOGRAPHIES
Patricia Paylore, comp. Natick, Mass. Army Natick Labs. Oct. 1967 76 p refs *Its* Ser. ES-34
(Contract DAAG17-67-C-0199)
(TR-68-27-ES; AD-663843)

The technical report brings together arid-lands bibliographies from the several thousand citations in the Pertinent Publications sections of subject chapters comparising the compendium, An Inventory of Geographical Research on World Desert Environments (U. S. Army Natick Laboratories contract DA49-092-ARO-71), adds appropriate bibliographies from other sources, and indexes the total number by geographic area and by subject. Of the nearly 6,000 references analyzed for this purpose, 269 were selected from Inventory Pertinent Publications, and combined with 93 additional citations for a total of 362. Annotations were modified or constructed to emphasize the bibliographical importance of the reference. Author (TAB)

N68-18047*# Volt Technical Corp., Washington, D. C.
RELATIONSHIP BETWEEN TYPE Pcl-OSCILLATIONS AND MAGNETIC STORMS [SVYAZ' KOLEBANIY TIPA Pcl MAGNITNYMI BURYAMI]
A. T. Plyasova-Bakunina and E. T. Matveyeva 8 Mar. 1968 3 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 8, no. 1, 1968 p 189–191
(Contract NAS5-12487)
(NASA-CR-93243; ST-GM-10-686) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The relationship between type-Pcl oscillations and magnetic storms are discussed in the light of the character of the former and by investigating their full spectrum of frequencies of appearance, namely the tendency to a shift of the time of pearl appearance in the course of 24-hour storm days. Author

N68-18057*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GEOCHEMISTRY OF LANTHANIDES IN BASALTS OF CENTRAL JAPAN
Akimasa Masuda Dec. 1967 28 p refs
(NASA-TM-X-63105; X-644-67-595) CFSTI: HC $3.00/MF $0.65 CSCL 08D

Lanthanides in six basalts from central Japan have been determined by a stable isotope dilution method. The chondrite-normalized lanthanide patterns are discussed in terms of estimated partition coefficients. An areal relationship was found in which the uniform enrichment factor, estimated from the lanthanide pattern, appears to decrease from the Pacific Ocean side towards the Japan Sea side. Cerium in Japanese basalts is depleted sometimes by a factor of about 13% in relation to the smooth

curves. To examine the heterogeneity of lanthanide distribution in rather small samples, two different portions of three rock specimens were analyzed. Author

N68-18085*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.
METHODS OF CALCULATING ATMOSPHERIC TRANSMISSION FUNCTIONS
S. Roland Drayson *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 36–49 refs (See N68-18082 08-33)

Advances in the field of atmospheric radiation have resulted in the need for accurate methods for the calculation of molecular absorption along slant paths in the atmosphere. Direct application of empirical data may be successful under conditions which can be closely simulated in the laboratory. Band models, when carefully employed, can be used for a wide variety of physical conditions. The development of high speed electronic computers has made attractive a third method, that of direct integration with respect to frequency, which is considerably more flexible, especially when used for nonhomogeneous absorption paths. Some advantages of this method are discussed and some examples of applications are given. Author

N68-18088*# Geophysics Corp. of America, Bedford, Mass.
INFERENCE OF BAND STRUCTURES FROM LABORATORY DATA
Thomas L. Altshuler (NASA. Electron. Res. Center) and J. I. F. King *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 96–112 refs (See N68-18082 08-33)
(Contract AF 19(628)-5738)

Gas spectra are described in terms of a probability distribution of absorption coefficients (probability distribution function) for carbon dioxide in the 4.3 micron band, using laboratory data. The transmission versus optical thickness was determined, and the transmission data were then inverted by using Prony's algorithm. This resulted in a series of multi-ramp profiles which were combined to yield a probability distribution function. Both the Elsasser and Goody models were inverted to yield probability distribution functions, and were compared to the CO_2 function. From this, it can be inferred that some spectral line clustering exists in CO_2. Furthermore, there is a finite probability that the absorption coefficient is zero for the CO_2 band and the Goody model. Author

N68-18089*# Michigan Univ., Ann Arbor. Willow Run Labs.
APPLICATION OF BAND MODELS TO INHOMOGENEOUS GASES
F. S. Simmons *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 113–133 refs (See N68-18082 08-33)
(Contract DAHC15-67-C-0062)

The formulation of band model expression for the calculation of spectral radiances from an inhomogeneous radiating body of gas is reviewed. By the method described, relations for the total radiances and equivalent widths of isolated Lorentzian lines along non-isothermal paths can be used to obtain expressions for average radiances and absorptances in spectral intervals that contain many lines but are small compared with the extent of the band. These expressions are based on a random-line band model with a nearly constant line strength distribution; the procedures for extracting the band model parameters from experimental absorbtance data are outlined. The physical implications of the resultant relations are discussed along with various aspects of the applications. Comparisons are made of the predictions of this model with observed spectra in the 2.7 μ bands of water vapor along a 60 cm path upon which various known temperature gradients were imposed. The inverse problem of deducing unknown temperature profiles from observed spectra and the application of band models for this purpose are briefly reviewed. Author

N68-18097*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
REMOTE SENSING OF ATMOSPHERIC WATER VAPOR AND OZONE USING INTERFEROMETRY
Barney J. Conrath *In its* Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 277–296 refs (See N68-18082 08-33)

The problem of obtaining vertical humidity profiles in the earth's troposphere from data obtained with an infrared interferometer spectrometer is examined. Emphasis is placed on the development of techniques which will utilize to the fullest extent the large number of data points obtainable with this type of instrument. One particular inversion technique, involving a linearization of the integral equation of transfer, is considered in some detail. Examples of applications to both synthetic data in the 6.3 micron band from model atmospheres and to real data obtained from a high altitude balloon flight are given, along with an analysis of the propagation of experimental error. Remote sensing of ozone, using data in the 9.6 micron band, is considered briefly. Author

N68-18102*# Philco-Ford Corp., Newport Beach, Calif. Applied Research Lab.
SOME THEORETICAL FREQUENCY AVERAGES FOR THE EMITTANCE OF A HOMOGENOUS GAS-PARTICLE CLOUD
Charlotte Decker Bartky *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 397–406 refs (See N68-18082 08-33)
(Contract F33615-67-C-1784)

Frequency averages, assuming an Elsasser band model, have been obtained for the one-dimensional beam emittance of a thick cloud composed of a radiating gas and nonabsorptive particles in the two limits, absorption or scattering predominant. These expressions, together with the trivial thin cloud and smeared line emittance, provide a means of calculating the radiance of a finite slab. Author

N68-18103*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
DETERMINATION OF ATMOSPHERIC TEMPERATURE PROFILES FROM SATELLITE RADIANCE MEASUREMENTS AT THE LIMB OF THE EARTH
James W. Burn *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 407–411 refs (See N68-18082 08-33)

Summary data are presented on the work being conducted to infer stratospheric and mesospheric temperature profiles from satellite radiance measurements. The preliminary results indicate: (1) Temperatures can be determined with a single spectral channel radiometer. (2) The spatial resolution is about 2.8 km. (3) Wide spectral bandwidths of approximately 2 microns within the 15 micron CO_2 band can be used. (4) Signal to noise ratios required for temperature determination at stratospheric and mesospheric altitudes can be obtained. (5) Temperature is computed directly from radiance ratios rather than radiance differences, eliminating the severe matrix mathematics problem. M.G.J.

N68-18104*# Florida State Univ., Tallahassee. Dept. of Meteorology.
ESTIMATING DIURNAL TEMPERATURE VARIATION AT THE STRATOPAUSE FROM HORIZON RADIANCE MEASUREMENTS
John C. Gille *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 412–415 refs (See N68-18082 08-33)

Calculations indicate that information about the size and phase of the diurnal temperature variation between 40 to 60 km may be obtained from the size and phase of the diurnal horizon radiance variation. In particular, horizon radiance measurements should indicate whether the rocket temperature measurements or theoretically calculated temperature variations are in error. Author

N68-18114*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FORUM. QUESTION 4: BAND MODELS AND NON-MODELS
In its Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 477–480 (See N68-18082 08-33)

The possibility of carrying out detailed calculations for water vapor at high temperature and at pressures between one-tenth atmosphere and one atmosphere is discussed. The main problem is identified as the determination of the line profiles when pressure broadening is present. The applicability of band models and the direct integration methods are discussed in relation to the accuracy and spectral resolution required. Comments are also offered on the importance of scattering and molecular emission in cloud reflectance studies, and the Mie scattering theory for the non-gray gas situation, and the development of growth curves for different pressure conditions. M.G.J.

N68-18177# Environmental Science Services Administration, Washington, D. C.
CIRCULATION OF SHELF WATERS OFF THE CHESAPEAKE BIGHT SURFACE AND BOTTOM DRIFT OF CONTINENTAL SHELF WATERS BETWEEN CAPE HENLOPEN, DELAWARE, AND CAPE HATTERAS, NORTH CAROLINA, JUNE 1963–DECEMBER 1964
W. Harrison, J. J. Norcross, N. A. Pore, and E. M. Stanley Jul. 1967 90 p refs *Its* ESSA Profess. Paper 3
GPO: $2.75

This study considers coastal or shelf waters from the shores of the Chesapeake Bight to the 183-m isobath. The purpose of the study is to reveal modes of transport of young fishes from offshore spawning sites to the nursery grounds. Earlier research on continental shelf waters off the Middle Atlantic Bight is summarized, including seasonal temperature and salinity distributions, effects of atmospheric conditions and river discharges, and the surface and bottom circulation of shelf waters. Data from drift bottles and seabed drifters on temperature and salinity variations as measured since 1963 are given. A complex pattern of surface circulation was noted during the summer of 1964, which is ascribed to winds, runoff, and thermal structure of the shelf waters. Vectors of surface and bottom drift are correlated with winds and runoff by means of a multiple linear regression procedure, and a partial correlation model between wind or runoff and surface and bottom drift components is constructed. Predictor equations containing four predictors are developed by subjecting 27 possible predictors to a computerized screening procedure. The root mean square error resulting from the application of a given equation to independent data is compared with the standard deviation of the observations from which the equation was derived. Equations are applied to two periods to determine whether the reconstructed water motions plausibly relate to extreme variations in numbers of Atlantic menhaden in 1958 versus 1964. K.W.

N68-18205# Ionosphären-Institut Breisach (West Germany).
STATISTICAL INVESTIGATION OF IONOSPHERIC DRIFT Final Scientific Report, Apr. 1, 1963–Mar. 31, 1967
Ewald Harnischmacher and Karl Rawer 31 May 1967 219 p
(Contract AF 61(052)-672)
(IIB-20; AFCRL-67-0503; AD-663443)

Drift data obtained with the three antennas fading method have been analyzed with a simple digitized method using 12 steps for direction and 14 for the speed value. The reduction method has been applied to observations at (A) Breisach, 1958/64, (B) Puerto Rico, 1954/60, (C) Eglin AFB, fall 1962. (A) concerns observations with 6 antennas i.e. in four triangles. By comparison it is stated that in spite of the rather large dispersion obtained with individual fades, the usual method using medians of about 10 fades gives rather satisfactory results. The angular error has median dispersion of plus or minus 18 degrees, standard deviation of plus or minus 27 degrees. A seasonal influence exists, it is rather small for the directional error but more important for the distribution of speeds. This influence is studied with differential statistical methods, and analyzed in terms of yearly and halfyearly variations. To (B) a complete set of monthly drift statistics is presented for the whole period. To (C) we show similar statistics for three months, and individual data obtained from the artificial ion cloud of four Firefly release experiments. Author (TAB)

N68-18220*# Pittsburgh Univ., Pa. Space Research Coordination Center.
EXCITATION OF THE AURORAL GREEN LINE BY DISSOCIATIVE RECOMBINATION OF O_2^+: ANALYSIS OF TWO ROCKET EXPERIMENTS
T. M. Donahue, T. Parkinson, E. Zipf, W. G. Fastie (Johns Hopkins Univ.), and R. E. Miller (Johns Hopkins Univ.) 22 Dec. 1967 31 p refs
(Contract NASr-179; Nonr-624(06))
(NASA-CR-93352; SRCC-64) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Analysis from photometric and electron flux data obtained during two sounding rocket auroral experiments has yielded volume emission rates for the N_2^+(0–0) first negative band and the OI(^{1}S–^{1}D) green line among other emission features. It is shown that excitation of the green line by electrons would require a cross section an order of magnitude larger than expected. From a calculation of the O_2^+ production rate it is shown that dissociative recombination can account for the entire green line emission if one fifth of all O_2^+ recombinations excite the ^{1}S state. This is the laboratory measured value. Analysis also shows that this mechanism can describe the relative variation of λ3914 and λ5577 in time varying auroras. Author

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N68-17230# Texas Nuclear Corp., Austin.
X-RAY ANALYSIS USING RADIO-ISOTOPE SOURCES
J. R. Rhodes, T. Furuta, and J. D. Hall 14 Jul. 1967 101 p refs
(Contract AT(40-1)-3224)
(ORO-3224-12; ITR-3) CFSTI: HC $3.00/MF $0.65

A portable, battery-operated X-ray fluorescence analyzer weighing 15 lbs was developed. It consists essentially of a NaI(Tl) scintillation counter probe and an electronic unit with a single channel pulse-height analyzer and reversible scaler. Radioisotope X-ray sources are used for excitation of the sample and, where necessary, balanced filters for resolution of neighboring characteristic X-rays. Preliminary feasibility studies are reported for determination of sulfur and ash in coal, calcium and iron in cement raw mix, copper in copper ores, gold in gold ore concentrates and silver in silver ores. In the last-named analysis comparisons are made with alternative methods of excitation using source target assemblies and detection using a high resolution cooled Si(Li) detector. Sensitivities of determination, based on counting statistics obtained in count times of 10 and 100 seconds, range from 0.002% for silver in ores to 0.2% for sulfur in coal. Author

N68-17263*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A VERY HIGH RESOLUTION RADIOMETRIC EXPERIMENT FOR ATS F AND G

I. L. Goldberg Jan. 1968 31 p
(NASA-TM-X-63112; X-622-68-26) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The synchronous altitude satellite offers a unique opportunity to continuously observe cloud cover and cloud motion over a large portion of the earth. It is proposed to use a scanning radiometer operating in the 10.5 to 12.5 micron spectral region to make these observations and surface temperature measurements both night and day. A radiometer containing an 8-inch aperture diameter Cassegrain telescope and a cooled (77°K) detector can make accurate temperature measurements with an effective subsatellite ground resolution of approximately 8 nautical miles. The analysis shows that because of diffraction effects and sensitivity requirements this resolution is about the best that can be attained with the 8-inch aperture radiometer. Over half of the estimated system weight of 110 pounds is due to the solid cryogen cooler. Because of the poor location space available on the spacecraft it does not appear feasible to use the much lighter radiative cooler. Author

N68-17276# Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.
THE DIGITAL MICRODENSITOMETER AS AN OPTICAL SYSTEM COMPONENT
H. W. Lorber 7 Jun. 1967 43 p refs
(EGG-1183-1330; L-848) CFSTI: HC $3.00/MF $0.65

The transfer properties of a digital microdensitometer are discussed. Information is presented for the optimization of digital microdensitometer parameters for specific photoprocessing tasks. NSA

N68-17329*# GCA Technology Div., GCA Corp., Bedford, Mass.
IMPROVEMENT AND OPTIMIZATION OF A MASS SPECTROMETER EMPLOYING A PHOTOIONIZATION SOURCE
Walter P. Poschenrieder and Peter Warneck Washington Mar. 1968 55 p refs
(Contract NAS1-6335)
(NASA-CR-1018; GCA-TR-67-12-N) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Further improvements of the photoionization mass spectrometer are described. The experiments performed showed the basic feasibility of analytical photoionization mass spectrometry. At the same time, certain limitations were indicated, particularly with regard to the discrimination of ions with different ionization potentials and coinciding mass numbers, e.g., CO and N_2. This limitation could be traced back to two main sources: namely, the second and higher order uv spectrum produced by the grating, and uv light scattering the monochromator. A considerable improvement has been achieved by the use of uv filters which reduce the intensity of the higher order spectrum and scattering by about two orders of magnitude. Accordingly, the detection limit for CO in N_2 was improved from 5000 to 100 ppm. The performance of a thin-metal indium filter was compared with an argon gas filter. Author

N68-17331*# Pennsylvania State Univ., University Park. Ionosphere Research Lab.
A TIME-OF-FLIGHT MASS SPECTROMETER SUITABLE FOR IONOSPHERIC COMPOSITION INVESTIGATIONS
H. T. Diem 25 Sep. 1967 64 p refs
(Grant NGR-39-009-032)
(NASA-CR-93184; SR-309) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A small sensitive time-of-flight mass spectrometer is being developed which appears to fulfill the necessary requirements for an ionospheric probe. The instrument's small size and light weight along with its high sensitivity and ability to operate at relatively high pressures make it a desirable tool for investigating the ion composition of the D and E regions of the ionosphere. Preliminary results are discussed. Author

N68-17379# California Univ., Livermore. Lawrence Radiation Lab.
GAMMA-RAY SPECTROMETERS FOR THE ASSAY OF COMPLEX MIXTURES OF LOW CONCENTRATION OF RADIONUCLIDES IN ENVIRONMENTAL AND BIOLOGICAL MATERIALS
Paul L. Phelps 24 Oct. 1967 19 p refs Presented at the 14th IEEE Nucl. Sci. Symp., Los Angeles, 31 Oct.–2 Nov. 1967 Submitted for publication
(Contract W-7405-ENG-48)
(UCRL-70544; CONF-671026-3) CFSTI: HC $3.00/MF $0.65

Solid state detectors, especially Ge(Li) drifted diodes, have given the biologist a new and powerful tool for determining the identity of radioactive species in biological samples. Often these samples contain very low quantities of radioactivity in a complex mixture of radionuclides. High resolution, maximum counting efficiency, suppression of background and Compton radiation and enhancement of photopeaks are required. A series of gamma-ray spectrometers has been developed to assay radionuclides in biological materials. These spectrometers have incorporated features that facilitate achieving these requirements. Samples up to 8.5 cm in diameter and 2.5 cm thick are now routinely analyzed. Author (NSA)

N68-17392# Aerojet-General Corp., Sacramento, Calif.
STRAIN GAGE PRESSURE TRANSDUCER EXPERIMENT 23/R511, NERVA PROGRAM Final Data Report
J. P. Oggerino Feb. 1967 39 p
(Contract SNP-1)
(TID-24144; RN-S-0326) CFSTI: HC $3.00/MF $0.65

Four Statham Model PA-812 and four Standard Controls Corporation Model 170-9 pressure transducers were irradiated in the Plum Brook Reactor Facility at Sandusky, Ohio. Both sets of transucers were subject to output signal degradation in excess of 25% of baseline values at a gamma heating rate of 0.5 W/gm. However, inadvertent pretest water damage of transmission cable assemblies contributed to the signal degradation. Posttest examinations revealed that physically the strain gage portion of the Statham transducers satisfactorily withstood the exposure. The integrated fast neutron flux was 9.0×10^{15} n/cm^2 ($E_n>1.0$ MeV); the gamma dose was 3.0×10^8 RADS (C). Author (NSA)

N68-17396*# University of Southern Calif., Los Angeles. Physics Dept.
MEASUREMENT OF ABSOLUTE PHOTON FLUX USING A SUPERCONDUCTING BOLOMETER Final Report, Feb. 1, 1966–Jul. 31, 1967
D. L. Judge 30 Jan. 1968 49 p refs
(Grant NGR-05-018-007)
(NASA-CR-93152) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A summary is presented of research undertaken in the design and instrumentation of an apparatus capable of efficiently producing and maintaining the low temperature needed for the proper functioning of a thin film supersonducding bolometer, and in the development of the sensitive detecting element itself. The theoretical aspects of bolometry are considered followed by discussions of the dewar system and superconducting detector development, the supporting instrumentation and apparatus, and the experimental results. R.N.A.

N68-17406*# California Univ., Berkeley. Forestry Remote Sensing Lab.
THE INTERPRETABILITY OF HIGH ALTITUDE MULTISPECTRAL IMAGERY FOR THE EVALUATION OF WILDLAND RESOURCES Annual Progress Report
William C. Draeger 30 Sep. 1967 76 p
(NASA Order R-09-038-002)
(NASA-CR-93187) CFSTI: HC $3.00/MF $0.65 CSCL 02F

High altitude multispectral imagery of the Bucks Lake Test Site in the Sierra Nevada Mountains of California was studied, and field data collections were made in an attempt to ascertain the optimum specifications for remote sensing imagery on which to identify and evaluate wildland resources. Examples of the information that can be extracted from various types of small scale imagery were prepared and discussed and a representative image interpretation guide for use in training interpreters was developed. Optimum image specifications were found to vary with both the resource involved and the type of management decisions to be made. It was concluded, however, that the best single image type for general purposes is that obtained using Ekta-Aero Infrared film in conjunction with a Wratten 12 filter. Of more flexibility, however, are several black-and-white photographic images in the visible and near infrared bands which can be studied individually, in concert, or converted into a color composite image by means of multicolor projection techniques. For specific applications such as soil moisture detection or study of geomorphology, sensors such as radar or thermal infrared detectors appear to be most advantageous.
Author

N68-17435*# ITT Industrial Labs., Fort Wayne, Ind.
A DAY–NIGHT HIGH RESOLUTION INFRARED RADIOMETER EMPLOYING TWO-STAGE RADIANT COOLING Quarterly Report, 1 Jul.–1 Oct. 1967
15 Sep. 1967 45 p
(Contract NAS5-10113)
(NASA-CR-93291; ITTIL-67-1046; QR-6) CFSTI: HC $3.00/MF $0.65 CSCL 20F

This report describes the completion of tests on the two-stage radiant cooler to be used in a 10.5 to 12.5 micron Day–Night High Resolution Infrared Radiometer and the initiation of construction on a breadboard radiometer. Thermal tests were made on single- and two-stage radiant coolers with aluminized mylar cone walls. Construction of the scan head and optics for the breadboard radiometer was begun and assembly of the necessary thermal and electronic test equipment continued. The feasibility of the two-stage radiant cooler was demonstrated under realistic thermal and mechanical conditions. The second-stage patch attained a temperature near 77°K when corrected for a minimum cold space reference reflectivity of 2%. The accuracy of temperature measurements is presently limited by the reflection of radiation from the first-stage cone to the patches by way of the flat space reference.
Author

N68-17485# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Strahlantriebe.
INVESTIGATIONS ON THE DESIGN OF A LIGHT PLANE PROJECTOR FOR THE DISPLAY OF HIGH-SPEED FLOWS [UNTERSUCHUNGEN ZUM ENTWURF EINES LICHTE-BENEN-PROJEKTORS FUER DIE SICHTBARMACHUNG VON STROEMUNGEN HOHER GESCHWINDIGKEITEN]
Siegfried Schmidt 1 Jul. 1967 135 p refs In GERMAN; ENGLISH summary
(DLR-Mitt.-67-16) CFSTI: HC $3.00/MF $0.65

Different optical methods are indicated by means of which a light plane may be produced. The current most practicable possibilities—application of a mirror system and/or cylindrical lens system—are described and systematically calculated and compared with each other regarding the deciding characteristic quantities (intensity of illumination, light distribution, size of measuring area). By giving data for several types, the cylindrical lens system, which in technical respect is more easily realizable, is demonstrated as being the most favourable solution.
Author

N68-17487# Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME 74, NO. 3: MOISTURE MEASURING BY RADIOSONDES [METEOROLOGISCHE ABHANDLUNGEN. BAND 74, HEFT 3: (FEUCHTMESSUNG DURCH RADIOSONDEN]
Klaus Nolte 1967 103 p refs In GERMAN; ENGLISH summary

The most common humidity sensors used in radiosondes are described. Average moisture profiles resulting from application of these sensors at the radiosonde of the Freie Universität Berlin are discussed. They show typical features for each kind of sensors. Special ascents were made to obtain a better knowledge of the "Carbon Hygristor" used. The results of these ascents are discussed, especially with respect to the so-called "moist calibration." Finally a short survey is given of new humidity measuring methods, their results, and the problems of stratospheric moisture measurements.
Author

N68-17494*# Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.
THE FEASIBILITY OF IDENTIFYING FOREST SPECIES AND DELINEATING MAJOR TIMBER TYPES BY MEANS OF HIGH ALTITUDE MULTISPECTRAL IMAGERY Annual Progress Report
Donald T. Lauer (Calif. Univ.) 30 Sep. 1967 113 p refs
(NASA Order R-09-038-002)
(NASA-CR-93185) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A systematic analysis was made of the factors affecting image tone or color, image detail, and stereoscopic parallax in order to improve the quality of remote sensing imagery. The optimum combination of factors was determined for identifying the major tree species and timber types in selected parts of the world, using imagery taken from earth orbit. The value of such advanced techniques as sequential imagery, spectrozonal imagery, and false color image enhancement for identifying forest species was investigated. A Gemini VII photo was used for test interpretations of tree species, timber type boundaries, and cultural patterns.
K.W.

N68-17495# Mound Lab., Miamisburg, Ohio.
SEMICONDUCTOR DETECTORS CONSTRUCTION AND APPLICATIONS
F. K. Tomlinson (M.S. Thesis—Miami Univ., Oxford) 22 Sep. 1967 27 p refs
(Contract AT(33-1)-GEN-53)
(MLM-1351) CFSTI: HC $3.00/MF $0.65

Construction and application principles of lithium-drifted silicon detectors were investigated with special emphasis on energy resolution characteristics. Silicon surface-barrier detectors were constructed to develop polishing, handling, and operational techniques applicable to the construction of lithium-drifted silicon detectors. Several surface-barrier detectors (active area, 210 mm^2) prepared for use in electron spectroscopy yielded resolution of 10 keV (FWHM) for 625 keV electrons. A lithium-drifted silicon detector was constructed for electron and low-energy gamma spectroscopy. The resolution of the drift detector was approximately 15 keV (FWHM) for 625 keV electrons. Resolution in this range was satisfactory for resolving the K and L conversion electrons from the decay of cesium-137. The response of a 2.35 mm deep detector to cobalt-57 gamma rays resulted in a resolution of approximately 16 keV (FWHM).
Author (NSA)

N68-17497*# IIT Research Inst., Chicago, Ill.
DESIGN, DEVELOPMENT, AND FABRICATION OF A PORTABLE SPECTROMETER-TYPE MONITOR Technical Summary Report, Jun. 29, 1964–Jan. 31, 1966
E. L. Grove 31 Jan. 1966 82 p
(Contract NAS8-11723)
(NASA-CR-61567; IITRI-U6010-18) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A small portable spectrometer was designed and fabricated to monitor oxygen and hydrogen as the free gas or as dissociation

products in the inert gas shield of the tungsten inert gas arc welding process. The fixed Eagle mount was chosen for its simplicity. It has only three optical components: the entrance slit, the collimating diffraction grating, and the camera (exit slits and photomultiplier tubes). A fiber optic bundle transmits the light from the arc to the spectrometer. One end of the bundle serves as the entrance slit and the other as the limiting aperture. The problem of varying blackbody radiation levels was solved by using an oscillating rectangular prism in the non-dispersed light beam which caused the emission line to oscillate across the exit slit. The sensitive solid state readout system is effectively an instantaneous direct ratio system. The ratio system relates the analytical to internal standard response readout by using the Devar ratio computer in each analytical channel. Author

N68-17540*# Volt Technical Corp., Washington, D. C.
SPACE PHOTOGRAPHY FOR THE GEOGRAPHIC STUDY OF THE EARTH
B. V. Vinogradov 28 Feb. 1968 16 p refs Transl. into ENGLISH from Bull. of the All-Union Geograph. Soc., no. 2, 1966 p 101–111
(Contract NAS5-12487)
(NASA-CR-93287; ST-GD-APH-10680) CFSTI: HC $3.00/MF $0.65 CSCL 14E

The technical aspects of space photography, some results of earth photography from both sounding rockets and satellites, and the advantages of space photography over aerial photography are discussed. Also mentioned are a number of shortcomings of space photography and certain problems concerned with its development from the viewpoint of geographic studies. R.N.A.

N68-17548# Sperry Gyroscope Co., Ltd., Brentford (England). Engineering Dept. Publication
RELIABILITY REPORT ON SPERRY AIRBORNE DATA ACQUISITION SYSTEMS
B. Goodburn and V. A. Hopkins Jul. 1967 17 p
(TR-266)

In the field of reliability engineering, consideration is given to electronic equipment which receives data signals from transducers, processes the data, and feeds them to recorder heads. The airborne data acquisition system (ADAS) discussed is made up of five parts: mandatory system, flight encoder, signal condition, signal conditioning unit and mandatory modules. From failure rates derived from the individual components and assemblies, the component mean time between failure (MTBF) rates of the system electronic package are given. Details are also given on the actual failure rates of the mandatory system based on flight data. Based on the relatively small proportion of hours flown by aircraft with ADAS, and MTBE, it is concluded that the electronics package can be expected to have a long trouble-free working life. B.S.D.

N68-17614*# Republic Aviation Div., Fairchild Hiller Corp., Farmingdale, N. Y.
MEASUREMENT OF ELECTRIC FIELDS IN THE IONOSPHERE Final Report
Gerald Levy, Herbert Jacobs, and Edgar Bendor Jan. 1968 126 p refs
(Contract NAS8-20663)
(NASA-CR-61189) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report describes the development of an experimental laboratory model of an electric field meter using the electron beam deflection techniques and the systems considerations for its use. This meter is designed to operate in the vicinity of a spacecraft within the ionosphere. The use of a weak electron beam (less than 1 microampere) provides a field sensing element which does not disturb the environment or the field it is measuring, while still permitting the association of the measured fields with the orbiting spacecraft at desired locations on, near, or far from its surface. The meter has a dynamic range from 10 mv/meter to 1000 v/meter with an accuracy of ±1mv/meter at 10 mv/meter and ±1% above 100 mv/meter. Author

N68-17619# Lockheed Missiles and Space Co., Sunnyvale, Calif.
USE OF A FABRI-PEROT WEDGE ETALON TO STUDY LOW DENSITY AIR FLOWS
A. I. Akimov and I. V. Skokov 1967 4 p refs Transl. into ENGLISH from Inzh.-Fiz. Zh. (Moscow), v. 13, no. 6, 1967 p 941–944

Details are given on the application of a Fabry–Perot etalon for studying low-density gas flows. In the etalon, gas flow passes between two plates on which mirror coatings were deposited. The wedge disposition of the plates allows the mirror surfaces to form a certain dihedral angle. The width and orientation of the fringes are determined by the valve of the optical density and its gradient in the medium being studied. Characteristic interferograms of rarefied gas flow around a 10 mm diameter cylinder, mounted perpendicular to the flow axis, show that a difference in fringe orientation permits different fringe displacements to be obtained in the same sections for the same flow parameters. The experimental results show the possibilities of using the wedge Fabry–Perot etalon for aerodynamic investigations of low-density flows, where the sensitivity of the ordinary two beams is inadequate. B.S.D.

N68-17628# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).
SEMICONDUCTOR DETECTORS [LES DETECTEURS A SEMICONDUCTEURS]
A. Roizes Dec. 1967 22 p In FRENCH
(CERTS-NT-02-5) CFSTI: HC $3.00/MF $0.65

Semiconductor detectors and gas detectors are compared in their ability to detect ionized particles. Detection of high energy particles needs a great penetration into the crystal whereas low energy particles can be detected by an augmentation of the carriers in avalanche diodes. ESRO

N68-17648# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati.
MEASURING DEVICE FOR FAST NEUTRON MONOPULSE SOURCES [APPAREILLAGE DE MESURE POUR SOURCE DE NEUTRONS MONOPULSEE]
R. Bardina Dec. 1966 38 p refs In FRENCH Sponsored in part by EURATOM
(LGI-66/14) CFSTI: HC $3.00/MF $0.65

A fast neutron counter consisting of a plastic scintillation counter, photo multiplier tube, integration devices and a telescope is described. This measuring device is meant for studying emission characteristics of fast neutron monopulse sources which consist mainly of thermonuclear machines with a confinement time of 0.1–10 gms. ESRO

N68-17664# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).
ELECTRON PARAMAGNETIC RESONANCE SPECTROMETERS [SPECTROMETRES A RESONANCE PARAMAGNETIQUE ELECTRONIQUE]
M. Do Khac Jan. 1968 12 p refs In FRENCH
(CERTS-NT-02-6) CFSTI: HC $3.00/MF $0.65

Electron paramagnetic resonance spectrometers are explained and the different operational modes of spectrometers of superheterodyne reception discussed. ESRO

N68-17671*# California Univ., Berkeley. School of Forestry.
THE EVALUATION OF RANGELAND RESOURCES BY MEANS OF MULTISPECTRAL IMAGERY Annual Progress Report

David M. Carneggie, C. E. Poulton, and E. H. Roberts 30 Sep. 1967 180 p refs
(NASA Order R-09-038-003)
(NASA-CR-93181) CSCL 14E

Various kinds of photography and other imagery for improving inventories of rangeland resources were studied, including multispectral photography, 18-channel line-scan imagery, thermal infrared and K-band radar imagery, and Gemini color photography. The results of remote sensing research on an annual grassland range, a perennial bunchgrass range, and in mountain meadows are discussed in terms of both present applications using fixed wing aircraft and potential applications, employing earth orbiting satellites. Included is a progress report on rangeland resource interpretations made from Gemini color photography. The limitations, advantages, and potential applications of such photography are discussed and recommended image quality specifications are given for an optimum orbital system for the inventory of range resources. Examples of color composites made by image enhancement techniques are shown and their advantages for increasing the interpretability of imagery are discussed. Limiting factors of satellite imagery and recommendations for further research are given. Author

N68-17680# Aerospace Corp., El Segundo, Calif. Technical Operations.
IMAGE SPECTRUM ANALYZER
Philip Rosten Apr. 1967 47 p
(Contract AF 04(695)-1001)
(TR-1001(2307)-17; SSD-TR-67-160; AD-663718)

A scanning device was developed for the purpose of recording a frequency power spectrum in a sample area of a photographic film in the form of a direct read-out. A rotary scanner, using an optical spot sufficiently small to obtain good modulation from a 250 line/mm target, was selected. The signal from the scanner was read out on a frequency analyzer which recorded the power spectrum as a chart trace. The wave form of the scanned film could also be studied in real-time as an oscilloscope trace for immediate analysis. Recorded frequency response at 500 lines/mm was 6 db above background from a random target. Author (TAB)

N68-17687 Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME 72, NO. 2: AUTOMATIC PICTURE TRANSMISSION (APT) SYSTEM OF WEATHER SATELLITES. AN INTRODUCTION TO THE FUNCTIONING AND METHODS OF EVALUATION OF THE NIMBUS 1 OBSERVATIONS [METEOROLOGISCHE ABHANDLUNGEN. BAND 72, HEFT 2. DAS AUTOMATISCHE BILDUEBERTRAGUNGS-APT-SYSTEM DER WETTERSATELLITEN. EINFUEHRUNG IN DIE ARBEITWEISE UND AUSWERTUNGSMETHODEN VON NIMBUS-1-BEOBACHTUNGEN]
Helga Wiener 1967 118 p refs In GERMAN; ENGLISH summary
CFSTI: $3.00

The automatic picture transmission (APT) system, installed in the weather satellites, permits APT ground stations to receive and to interpret cloud pictures and other weather satellite observations immediately. The APT system was used for the first time in NIMBUS 1 in August/September 1964. This paper will give a description of the APT system and its working methods which are followed by some consideration about the relations between satellite track and receiving station. There is also an extensive description of the implements necessary for daily reception and interpretation of the satellite pictures. Furthermore NIMBUS 1 pictures and conventional analysis are compared to show the meteorological importance of the cloud pictures. Author

N68-17690# Department of Forestry, Vancouver (British Columbia). Forest Products Research Lab.
A COMPUTER PROGRAM FOR EVALUATION OF STRAIN GAUGE ROSETTE READINGS
C. K. A. Stieda Oct. 1965 14 p refs
(VP-X-4)

The experimental analysis of stresses in structures frequently requires observation of strains in certain selected directions. At any particular point, measurements in at least three different directions have to be made in order to define completely the condition of strain. With a set of three observations it is then possible to obtain for this point the directions of the principal strains as well as normal and shear strains in any direction. If an electronic computer is available, these computations can be done very quickly and, therefore, become more practical than a graphical solution. A suitable program for computing shear strains and principal strain directions has been written in Fortran IV for use with the IBM 7040 computer. Author

N68-17765# Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.
THE IN-FLIGHT DEPLOYMENT OF HEAVY PAYLOAD TRAINS BENEATH ASCENDING HIGH-ALTITUDE BALLOONS
Francis X. Doherty, Chester G. R. Czepyha, and Robert J. Reddy Nov. 1967 29 p refs Sponsored by DASA *Its* Instrumentation Papers, no. 134
(AFCRL-67-0634; AD-663716)

In 1957 and 1958, the Air Force Cambridge Research Laboratories (AFCRL) developed techniques for the in-flight deployment of several 50-lb instrumentation canisters along a 3500-ft balloon-borne train. This report describes an extension of these techniques to position much heavier instruments in a similar but more precise manner. Author (TAB)

N68-17834# California Univ., Berkeley. Lawrence Radiation Lab.
AUTOMATIC CONTROL SYSTEM FOR DETECTION OF NUCLEAR MAGNETIC RESONANCE
C. C. Wang 3 Aug. 1967 31 p
(Contract W-7405-ENG-48)
(UCRL-17715) CFSTI: HC$3.00/MF$0.65

An automatic control system for detection of the nuclear magnetic resonance is described. The system is the combination of the commercially available instruments and the modular units developed in the Lab. The frequency of interest is anywhere between 100 MHz and 900 MHz. The range of the frequency sweeping is determined by the sample under observation, which is seldom over 100 MHz. The accuracy of the frequency repetition is within 100 kHz. Author (NSA)

N68-17861# Army Electronics Labs., Fort Monmouth, N. J.
ULTRALINEAR FLYING-SPOT SCANNER
Henry Schlussler Sep. 1967 32 p
(ECOM-2889; AD-663794)

An investigation was conducted to establish means of improving the accuracy of photographic data-scanning devices using flying-spot scanners which employ a repetitive, unmodulated, single-line scan. Reduction to a minimum of the distortions and nonlinearities inherent in this type of scanning system was attempted by using an accurate optical mask and a precision source of time as the standards for measuring linearity. The unltralinear flying-spot scanner demonstrated that, through the use of an optical-electronic feedback system, the sweep position accuracy of a flying-spot scanner can easily be held to better than one part in a thousand. Therefore, to a degree not previously possible, the techniques developed in this investigation can be used to greatly improve both the long- and short-term stabilities of single-line-scan flying-spot scanners. Author (TAB)

N68-17863*# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
THE APPLICATION OF FEEDBACK IN MEASUREMENT
Gerard J. Born and Enoch J. Durbin Oct. 1967 28 p Suppl. to NASA-CR-61539; See N68-17064
(Contract NAS8-5343)
(NASA-CR-93143; NASA-CR-61539) CFSTI: HC $3.00/MF $0.65 CSCL 14B

To point out the necessary conditions for achieving measurement improvement by the use of feedback in instrumentation design, the basic problems connected with feedback instrumentation are discussed and compared with the conventional instrumentation. The elements of a measurement system are examined in relation to a comparator, a reference, a gain element, and a transducer or converter. The required steps to obtain a true value and dimension are listed, and the possibility of error reduction and classification of instrument errors are delineated. The basic measuring systems are analyzed and the precision of each is determined. The advantages and the effect of gain elements on a direct measurement system are given. An assessment is made of the balancing measurement system which directly compares the quantity to be measured with a reference having the same physical quantity. The application of feedback to a balancing measurement system is investigated, and a comparison is made of an auto-balancing measurement and nonautomatic balancing measurement. B.S.D.

N68-17878# Brown Univ., Providence, R. I. Metals Research Lab.
IMPROVEMENT IN ULTRASONIC VELOCITY MEASUREMENT TECHNIQUES Final Technical Report, 1 Nov. 1966–31 Oct. 1967
Bruce B. Chick, George P. Anderson, and Rohn Truell Oct. 1967 24 p refs
(Contract NOw-66-0105-d)
(AD-663534)

A Pulsed Echo ultrasonic velocity measurement system with the design objective of resolving changes of time of 10 to the -11th power seconds (10 picoseconds) has been developed. Performance data detailed later in this report will show that, while the design objective has not yet been fully realized, the system is capable of resolving 40 picosecond changes and is therefore already an extremely valuable tool. The approach that has been utilized in developing the system can best be described as a brute force time interval measurement. Time Interval is measured from a D.C. Turn On pulse (which triggers an R.F. Pulsed Oscillator) to a shaped, selected R.F. cycle from an acoustic echo later in the echo train (where the echo train is generated in an acoustic medium when an appropriate transducer coupled to the medium is driven by the R.F. Pulse Oscillator). The selected R.F. cycle is used as a turn off pulse. The time interval is measured by means of a digital delay in steps of 100 nanoseconds (10 to the -7th power seconds) (to a maximum of 100 microseconds) and an analog vernier of 100 nanoseconds. The vernier can be expanded to a maximum sensitivity of 1 nanosecond full scale with a resolution of 10 picoseconds per division on a calibrated taut-band meter. Author (TAB)

N68-17886# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A NEW METHOD FOR CAPACITANCE MEASUREMENT
Shin-min Chiu and Jen-chi Wu 28 Apr. 1967 11 p Transl. into ENGLISH from Tien Tzu Chi Shu (Communist China), no. 11, 1965 p 19–20, 23
(FTD-HT-66-635; AD-663620)

A circuit was designed for capacitance measurement and through actual use demonstrated that the circuit has the following outstanding features: first, the circuitry is simple, and there is no need for induction coils; second, it has a wide range of measurement ability, extending from a few picofarads to a few microfarads. Such a range is sufficient for practical use; and third, the circuit gives a direct reading, hence it is fast and convenient. Author (TAB)

N68-17888# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
GYROSCOPIC ORIENTATION
Yu. B. Kashevarov 15 May 1967 77 p ref Transl. into ENGLISH of the book "Giroskopicheskoye Oriyentirovaniye" Moscow, Voyenizdat., 1964 p 1–77
(FTD-MT-65-441; AD-663622)

Contents: Peculiarities of topographic preparation of contemporary artillery and rockets; Short history of the development of gyro-instruments; Basic information from mechanics, necessary for studying the elementary theory of gyroscope; Gyrocourse indicator and its use for topographic surveying (basic rules of motion of a gyroscope; precession of gyrocourse indicator; losses of gyroscope stability; basic peculiarities of the design of a gyrocourse indicator, emanating from an analysis of accuracy of its work; basic peculiarities of the use of gyrocourse indicator; use of the gyrocourse indicator for topographic surveying of rockets and artillery); The gyrocompass and its use for topographical surveying (principles of layout and work of a gyroscopic compass; peculiarities of design and use of pendular gyrocompass designed for topographic works; recommendation on reducing the time of orientation); Short description of the layout of Mine Surveyor Gyrocompass MG. TAB

N68-17905# Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology.
PERFORMANCE OF THIN FILM HUMIDITY SENSORS
Joseph DelPico 15 Oct. 1967 76 p refs
(Contract F19628-67-0228)
(AFCRL-67-0543; SR-1; AD-663757)

Various hygroscopic materials have been considered for use as the thin film dielectric in a condenser, which is to be used as the humidity sensing element in an electric hygrometer. The requirement of such a dielectric is that it approach equilibrium rapidly and display both reversible and reproducible humidity-electrical characteristics. Polymerous dielectrics have shown an extremely slow rate of response and it is suspected that the rate of Knudsen diffusion through many fine tortuous pores is responsible. Anodic aluminum oxide films produced in a sulfuric acid electrolyte have recently shown a rapid rate of response as well as a reproducible response toward humidity changes. The major limitation hindering the use of such humidity sensing elements is their long-term calibration drift, which causes the elements to become less sensitive toward humidity variations. Results have shown that a change in the concentration of various species of chemisorbed water vapor initially present on the pore walls may be responsible for the observed calibration drift and that further experimentation in this area is warranted. Author (TAB)

N68-17919# Technical Operations Research, Burlington, Mass.
EXTENDED DYNAMIC RANGE PROCESSING Final Report, 10 Oct. 1966–10 Oct. 1967
A. Shepp, W. Kammerer, and R. Shuman Nov. 1967 52 p refs
(Contract F19628-67-C-0082; ARPA Order 450)
(TO-B-68-6; AFCRL-67-0633; AD-663437)

Four Kodak films - Pan-X, Plus-X, Tri-X, and High-Speed Infrared - were exposed to slit images (1.7 x 14 mm) over a range of 10,000 E. Samples were developed in D-19 and D-76 for high- and low-contrast control and in three Tech/Ops extended dynamic range (XDR) developers - E-20A, E-20B, and Type IV. Subsequent analyses showed that the XDR developers produce lower granularity than the control developers and thus greatly reduce the apparent flare and increase detectivity, even at low density and gamma. Author (TAB)

N68-17937# Bureau of Mines, Denver, Colo.
A METHOD OF MEASURING SURFACE TEXTURE OF ROCK
Frank G. Horino, John R. Hoskins, and Merlyn L. Ellickson Mar. 1968 15 p refs
(BM-RI-7095)

An instrument is described for quantitatively identifying texture of rock surfaces produced by grinding or extremely rough surfaces beyond the range of commercial surface measuring instruments. The transducer for the instrument is a linear variable differential transformer that converts mechanical motion caused by surface roughness, waviness, and lay to an electrical output. The electrical output is recorded graphically as an X–Y plot of the line traversed on the rock surface. Details of the synthesized device and its calibration are given. The sensitivity of the unit is 2 percent of the scale setting of the amplifier. The horizontal scale is adaptable from 1/4 inch to 15 inches of specimen length with a sensitivity of 0.01 inch if a 10 to 1 magnification is used and 0.1 inch if a 1 to 1 magnification is used. Author

N68-17957# Texas Instruments, Inc., Dallas.
HIGH-SPEED, LONG-WAVELENGTH COHERENT RADIATION DETECTORS Semiannual Technical Summary Report, 15 May–15 Nov. 1967
R. L. Williams Dec. 1967 39 p refs
(Contract N00014-67-C-0497)
(TI-08-67-90; AD-663749) CFSTI: HC$3.00/MF$0.65

The principal consideration in the heterodyne mode of signal detection is the influence of the local oscillator power on detector characteristics. It is shown that misalignment of the local oscillator signal can seriously degrade detection performance with the detector geometry presently used. For signals incident through transparent contacts, misalignment problems are removed. Characteristics of transparent contacts are reported. It has been established that dielectric relaxation time constant effects occur above a certain electric field. These effects, as well as nonlinearities of signal and detector resistance changes, occur at fields for which the drift length of holes is comparable to the electrode separation. This has been shown to be valid by examining detectors having different thicknesses and material having a wide range of carrier lifetimes. Mercury-doped germanium samples which have been subjected to gallium diffusions have larger activation energies than untreated material. This change has been identified with copper gettering by the gallium-diffused surface layer. Author (TAB)

N68-17964# California Univ., Berkeley. Lawrence Radiation Lab.
COMPUTER-CONTROLLED DATA REDUCTION OF SPARK CHAMBER FILM
Donald Zurlinden 27 Jul. 1967 25 p
(Contract W-7405-ENG-48)
(UCRL-17695) CFSTI: HC$3.00/MF$0.65

An automatic scanning and measuring system was developed for the reduction of data from spark chamber film. Author (NSA)

N68-18006# Japan Atomic Energy Research Inst., Tokyo.
CHARACTERISTICS OF A FLUORITE THERMOLUMINESCENT DOSIMETER WITH CHARGE-SENSITIVE AMPLIFIER
Toshiyuki Nakajima and Tadashi Hashizume (Natl. Inst. of Radiol. Sci.) Jan. 1968 14 p refs Transl. into ENGLISH from Oyo Buturi (Tokyo), v. 35, no. 12, Dec. 1966 p 870–875 Submitted for publication
(NSJ-TR-99) CFSTI: HC$3.00/MF$0.65

The characteristics of a thermoluminescent dosimeter of fluorite crystals were investigated by a method in which a charge-sensitive amplifier was used. The reading system of this method is to integrate the intensity of emission glow under the required peaks. The data for zinc fluorite doped with manganese and for lithium fluorite have been obtained as the basic data of thermoluminescence dosimetry covering the range of X-ray exposure dose from 10^{-1} to 10^{3} roentgen. Author

N68-18151# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).
ON THE FORMATION OF BUBBLES IN LIQUID HYDROGEN
G. Harigel, G. Horlitz, and S. Wolff *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 389–404 refs (See N68-18147 08-11)

Photographs of electron tracks having energies around 2 GeV were made in the DESY 85cm bubble chamber with a scale one optical system in bright field illumination. Growth and recompression of bubbles as well as bubble densities were observed between 24.5 and 28.0°K. Bubble size as a function of time was measured at different temperatures, with expanded pressure and overpressure as varying parameters. Measurements show that heat transfer plays the predominant role in the process of bubble growth, in accordance with the theory of Plesset and Zwick. Considering the time dependence of parameters, reasonable agreement was found between calculations and measurements for small growth times. For constant bubble densities the velocity of bubble growth increased rapidly with decreasing operating temperatures of the chamber. Heat transfer was also predominant in bubble recompression, whereas inertial forces appeared negligible. The ascent of bubbles was of importance in the case of recompression, and slight agreement with theoretical predictions by Aleksandrov et al. was found. S.C.W.

N68-18162# Argonne National Lab., Ill.
INSTRUMENTATION FOR THE ANL 12-FT HYDROGEN BUBBLE CHAMBER
J. D. Simpson *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 501–505 Sponsored by AEC (See N68-18147 08-11)

Instrumentation for the control room of the Argonne 12 ft bubble chamber is described. Proposed instrumentation includes a small computer which will serve principally as an automatic data logging system. The system will also be used to: (1) provide a reliable, periodic log of significant parameters and record alarms as indicated on the main alarm panels; and (2) provide for analogue to digital conversion of the pressure pulse in the chamber and the chamber static pressure and VPT pressure for the data box presentation. The system will incorporate a fast line printer to eliminate stacking problems should several alarms arrive in a short time interval. An important responsibility of bubble chamber instrumentation is to present pertinent data on the film in formats convenient to as many users of the film as possible. The planned film format is illustrated and associated data processing equipment is described. Other techniques include: piezoelectric dynamic pressure transducers in the chamber, an ultrasonic transducer at the chamber high point to detect any large bubble there, and Ga–As diodes to measure cool-down of the supermagnet cryostat. Instruments employed in the cryogenic process systems are of the conventional pneumatic type. In the event of power failure, a steam turbine driven generator will automatically assume the electrical load. Whenever required, cables are run in conduits purged with dry nitrogen. Conduits entering the control room from the bubble chamber area are fed through a sealed bulkhead. Detailed floor plans for the control room are included. S.C.W.

N68-18172# Royal Aircraft Establishment, Farnborough (England).
THE COMPREHENSIVE CALIBRATION OF KINETHEODOLITES
P. B. N. Nuttall-Smith and Monica J. N. Marchant Jan. 1967 84 p refs
(RAE-TR-67007; AD-663579)

The biases of a kinetheodolite are discussed and a method of calibrating is considered, which is suited to use in the field, the stars being used as reference objects. The mathematical model is given and the computing procedure and the significance of the biases found are discussed. The number of observations required is considered in relation to the desired accuracy of calibration. Author (TAB)

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N68-17315# Tokyo Univ. (Japan). Inst. for Industrial Science.
FUNDAMENTAL APPROACHES TO CONTROL OF POWDER FLOWS
Tadashi Yamashita and Masahiro Mori Nov. 1966 85 p refs *Its* V. 17, No. 1, Ser. No. 108

General aspect of a powder transportation process are discussed. Problems related to control of powder flow from a viewpoint of control engineering are raised, and the flow out characteristics of powder from a vessel are examined. A combination hopper and a fluidizing trough is proposed, and its characteristics are studied and analyzed. Based on these data, the feasibility of a new powder flow controlling device is presented. Author

N68-17318# Israel Program for Scientific Translations, Ltd., Jerusalem.
STAUB REINHALTUNG DER LUFT—HYGIENE EFFECTS AND CONTROL OF DUSTS, FOGS, GASES, VAPOURS, RADIOACTIVE PARTICLES
1967 48 p refs Transl. into ENGLISH of the Publ. Staub Reinhaltung der Luft (Duesseldorf), v. 27, no. 3, Mar. 1967 Transl. for Dept. of Health, Educ., and Welfare and NSF
(TT-67-51408/3) CFSTI: HC$3.00/MF$0.65

This volume contains articles dealing with the following: (1) testing of several cyclone separators of different dimensions and of different manufacture; (2) design of cyclones for given maximum particle size, pressure loss, and flow rate; (3) wet scrubbing by means of aerosols in turbulent dust-laden gases; (4) study of the influence of wind on suction apparatus, using the potential flow theory; (5) determination of the gas flow rate by the reference-velocity method; and (6) photochemical formation of nonvolatile droplets from organic vapors in air. Several new developments and patent applications are summarized. K.W.

N68-17564*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NONCAVITATING PERFORMANCE OF TWO-AREA-RATIO WATER JET PUMPS HAVING THROAT LENGTHS OF 7.25 DIAMETERS
Nelson L. Sanger Washington Mar. 1968 62 p refs
(NASA-TN-D-4445) CFSTI: HC$3.00/MF$0.65 CSCL 13K

The performance of two jet pumps having low nozzle- to throat-area ratios was evaluated in a water facility and compared to theoretically predicted performance. The purposes of the investigation were to gain a better insight into the flow mechanisms involved in low-area-ratio jet pumps, and to compare the abilities of two existing one-dimensional analyses to predict jet pump performance over a wide range of operating conditions. Two nozzles were evaluated experimentally and the test pump consisted of one of the two nozzles and one test section, the latter having a throat diameter of 1.35 inches (3.43 cm), a throat length of 7.25 diameters, and a diffuser included angle of 8°6' (0.141 rad). The nozzles had exit diameters corresponding to nozzle- to throat-area ratios of 0.066 and 0.197. Each nozzle was operated at several spacings of the nozzle exit upstream from the throat entrance over a range of from 0 to 3 throat diameters. At small nozzle spacings (up to 1 throat diameter) a simple one-dimensional analysis predicted performance quite closely. The theory also demonstrated that low efficiencies exhibited at low ratios of secondary to primary (high pressure) flows are due to inefficient mixing, whereas low efficiencies at high flow ratios are due largely to friction losses. A modified theory, which attempted to account for the effect of the mixing profile in the throat, required more computational effort and did not improve correlation with experimental performance. Author

N68-17610*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
SPIRAL GROOVE FACE SEAL CONCEPTS; COMPARISON TO CONVENTIONAL FACE CONTACT SEALS IN SEALING LIQUID SODIUM (400° TO 1000°F)
Thomas N. Strom, Lawrence P. Ludwig, Gordon P. Allen, and Robert L. Johnson 16 Nov. 1967 40 p refs Presented at ASME Seal Symp., Pittsburgh, 12–16 Nov. 1967
(NASA-TM-X-52327) CFSTI: HC$3.00/MF$0.65 CSCL 11A

Conventional face contact seal performance was improved by incorporation of the spiral-groove geometry. Both conventional face contact seals and seals with spiral grooves were used to seal liquid sodium at a pressure of 20 pounds per square inch gage (14.0 N/cm^2 gage), and a sliding velocity of 79 feet per second (24 m/sec). In comparison with conventional face contact seals, seals with spiral grooves had negligible leakage. The wear and contact patterns indicated that the spiral-groove seal operated with separation of the sealing surfaces, which is necessary for long life. Supporting studies (sealing oil) on face contact seals employing the spiral-geometry is discussed. Successful low-leakage operation was not achieved with conventional face contact seals having carbide seal seats and nosepieces (hard on hard). Thermal and pressure distortions caused edge contact, wear, and scoring. Conventional face contact seals having seal seats and nosepieces with wear-in properties (soft on hard) showed more leakage than those with carbide sealing surfaces. Author

N68-17688# Department of Forestry, Vancouver (British Columbia). Forest Products Lab.
FORCED-VIBRATION, LOW-FREQUENCY LOAD MACHINE
B. Holmes and R. O. M. Kabos Aug. 1967 12 p
(VP-X-22)

A simple hydraulic machine was designed for fatigue testing of wood specimens in compression. The machine applies a specific mechanical load in a cyclic manner approximating squarewave loading. The loading pattern can be programmed between one cycle per second and one cycle per 10,000 seconds. Also, a static load can be applied indefinitely. Author

N68-17717# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PLASTIC DEFORMATION MODIFICATION OF SHEET MATERIAL WITH HELP OF ROLLERS [PLASTICHESKAYA DEFORMATSIYA PRI FORMOIZMENENII LISTA PRI POMOSHCHI VALKOV]
B. A. Druyanov *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 187–192 refs (See N68-17701 08-23)

The process of modifying sheet material with the help of rough rollers has a definite similiarity with sheet material compression by rough plates. In both cases the tangential stress on the line of contact establishes a zone where the metal adheres to the tool and where it slips. The theory of flat flow in rigidly plastic bodies provides solutions to the modification of sheet metal by the application of static indeterminable problems. A solution for sheet metal compression is obtained when the thickness of the sheet is equal to the width of the plates. In this case the plastic regions consist of two rigid triangles. This article plots an analogous resolution for the considered problem. Author

N68-17774# Ballistic Research Labs., Aberdeen Proving Ground, Md.
DETERMINATION OF SAMPLE SIZE FOR MINIMIZING PROBABLE COSTS IN DESTRUCTIVE TESTING
George H. Jonas Oct. 1967 47 p refs
(BRL-R-1376; AD-663822)

A method has been developed and tables have been constructed for determining the sample size, n, and the acceptance number, c, for single sampling plans for destructive testing, subject to the reauirement that the sum of the cost of inspection plus the net cost of the residues of rejected lots shall be a minimum. In order to accomplish this result, suitable approximations were used in the statistical treatment to replace some of the rather cumbersome expressions encountered in an exact formulation. Tables for the type of sampling inspection problems studied are for lot sizes up to 100,000 and for combinations of values for the true process average, and p sub t, the lot tolerance fraction defective, up to 0.10 and 0.40 respectively where the true process average < p sub t. The Consumers Risk is taken to be P sub c = 0.10 as in single sampling inspection tables of Dodge and Romig. An example has been included to show how the tables can be used. Author (TAB)

N68-17912# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ADDITIVES TO OILS TO LOWER FRICTION AND WEAR

I. E. Vinogradova 11 May 1967 106 p refs Transl. into ENGLISH of the book "Prisadki k Maslam Dlya Snizheniya Treniya i Iznosa" Moscow, Gostoptekhizdat., 1963 p 1–111

(FTD-MT-64-388; AD-663343)

The book is devoted to oil additives for lowering friction, wear and preventing of jamming of friction surfaces. The book contains materials on antifriction, antiwear and antiburr additives to oils, about contemporary methods of selecting additives and about the mechanism of their action. Consideration is given to the principles of selecting oil additives for specific types of equipment and requirements for additives taking into account the conditions of work of machines of different assignment. TAB

N68-17965# Rock Island Arsenal Lab., Ill. Research and Engineering Div.

RELATIONSHIP OF PERMEABILITY OF A GREASE TO ITS STABILITY

S. Fred Calhoun Nov. 1967 28 p refs

(RIA-67-2770; AD-663815)

Nine greases were investigated. One was a commercial grease conforming to a Military Specification. Eight were made up experimentally from two different oils and five types of thickeners. Their physical characteristics, mechanical stabilities, and oil separations were determined. They were permeated with four different types of oils and their permeability coefficients determined. The permeabilities were in the same general order as their oil separations but differed significantly with the different oils used. This indicated some possible interaction between the oils and the thickener fibers. There was no correlation whatever between the permeability coefficients and the mechanical stabilities of the greases as established on the grease worker and Shell Roll tester. This would suggest that the mechanical stability of a grease had no relationship to its permeability coefficient. Author (TAB)

N68-18124*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

BEARINGS AND SEALS FOR CRYOGENIC FLUIDS

H. W. Scibbe Washington 1968 39 p refs Presented at Fuels and Lubricants Meeting Spon. by the Soc. of Automotive Engr., Cleveland, 13 Nov. 1967

(NASA-TM-X-52415) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Bearings and seals in rocket engine turbopumps operate directly in the cryogenic propellant. Special design and lubricating techniques are required since ordinary oils and greases become glasslike solids at these extremely cold temperatures. The bearing load carrying surfaces are lubricated by thin transfer films. The lubricant is provided by the bearing cage which is usually fabricated from a self-lubricating Teflon compound. Material compatibility and wear are the important factors for face contact seals in these cryogenic fluids. Carbon, normally used in seal nosepieces, has violent reactions when run in liquid fluorine, an extremely chemically active fluid. Wear at the rubbing contact is minimized when the seal is designed for positive face separation with acceptable leakage. Author

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N68-17336# Defence Standards Labs., Maribyrnong (Australia).

VISUALIZATION OF A 10.6 MICRON LASER BEAM

J. Tregellas-Williams, D. R. Skinner, and A. B. Lacey Jun. 1967 7 p

(DSL-TM-20)

Two techniques are presented for the examination of a 10.6 μ laser beam. The first system, using infra-red quenching of a phosphor, allows the shape of the beam to be examined continuously provided the power exceeds 200mW. The second system uses the melting of organic crystals for the rapid location of beams having powers as low as 30 mW. Author

N68-17773# Ballistic Research Labs., Aberdeen Proving Ground, Md.

ATMOSPHERIC EFFECTS ON THE BEAM PROPAGATION OF THE XM-23 LASER RANGEFINDER

Paul H. Deitz Sep. 1967 37 p refs Presented at the Laser Range Instrumentation Seminar-in-Depth, El Paso, Tex., 16–17 Oct. 1967

(BRL-MR-1871; AD-663810)

A special optical receiver with a 2-foot input aperture was used to measure beam cross sections of the XM-23 Laser Rangefinder. The standard deviations of the received energies were determined for pathlengths from 200 to 1500 meters. The index structure constant, c sub n (derived from the measured thermal structure function) and the solution to the spherical wave equation were used to predict the standard deviations of the optical energy distributions. The predictions based on meteorological measurements were compared to the standard deviations of the optical measurements for high scintillation conditions. Author (TAB)

N68-17963# Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering.

RAYLEIGH SCATTERING OF RUBY LASER LIGHT IN NEUTRAL GASES

Ralph R. Rudder (Ph.D. Thesis) and David R. Bach Nov. 1967 195 p refs

(Contract DA-31-124-ARO(D)-403; ARPA Order 675; Proj. Defender)

(Rept.-07599-15-T; Rept.-6092.10-P; AD-663819)

Measurements are described of Rayleigh scattering from atoms and molecules in the gaseous state at one atmosphere. The use of a Q-switched ruby laser of 8 MW average power and care in minimizing spurious light permitted the determination of very small depolarizations. In agreement with theoretical predictions, the depolarization ratio (for linearly polarized light) or argon was found to be vanishingly small. Similarly, for helium. However, xenon and methane exhibited nonzero depolarization ratios. It is found that departures from ideal gas behavior provide the most plausible explanation for these findings. Calculations from currently available theory are presented to support this assertion. The effect of nuclear spin in xenon-129 is considered and shown to contribute negligibly to the measured depolarization. Depolarization ratios were also measured in hydrogen, deuterium, nitrogen, and nitrous oxide, and found to be lower than generally accepted values. Author (TAB)

N68-18099*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
APPLICATION OF LASER DOPPLER TECHNIQUES TO TURBULENT VELOCITY MEASUREMENT
R. M. Huffaker, E. Rolfe (Raytheon Co., Sudbury, Mass.), and Albert V. Jelalian (Raytheon Co., Sudbury, Mass.) *In its* Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 328-358 ref (See N68-18082 08-33)

Details are given on a laser Doppler technique developed for measuring mean and fluctuating gas velocities, in which the velocity is measured by scattering of particles in the gas (Mie scattering). The parameters that influence the frequency spread and intensity of the heterodyned signal are discussed, along with the effects of aperture size, particle size, particle size distribution, convergence of beams, optics, and polarization of the heterodyned signal. Measurements made on wind tunnel and rocket jet type flows are compared with other instrumentation such as hot wire anemometers and pitot tubes. Results show the feasibility of obtaining precise and accurate measurements. Design principles are outlined for a three-dimensional laser Doppler velocity instrument for measuring vector velocity. The potential of the laser Doppler technique for wind velocity measurements is assessed. The coherent versus incoherent detection and the signal-to-noise level equation for atmospheric measurements are also presented. M.G.J.

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N68-17265# Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu.
SOME PROPERTIES OF THE CERMET UC-U
D. Jakes and M. Voboril Aug. 1967 5 p refs
(UJV-1356)

A UC-U cermet containing 50 mole % UC was prepared from powdered metallic U and carbon black by sintering under A at 1150°C for 2 hr. It was determined by X-ray analysis and metallographic examination that penetration of U between the spheroidal carbide particles was close to the conditions of full wetting. The mean particle size of the UC was found to be dependent on the sintering temperature. NSA

N68-17317*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECTS OF COMPOSITION AND HEAT TREATMENT ON HIGH-TEMPERATURE STRENGTH OF ARC-MELTED TUNGSTEN–HAFNIUM–CARBON ALLOYS
L. S. Rubenstein Washington Feb. 1968 31 p refs
(NASA-TN-D-4379) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The effects of composition, heat treatments, and substructure on the strength and ductility of tungsten–hafnium–carbon (W–Hf–C) alloys were studied. The compositions ranged from 0.23 to 1.76 atomic percent for hafnium and from 0.179 to 0.942 atomic percent for carbon, with carbon to hafnium ratios from 0.17 to 2.80 and calculated amounts of hafnium carbide ranging up to 1.5 volume percent. The high-temperature tensile strengths of swaged, recrystallized, solution-annealed and aged alloys increased with increasing hafnium carbide contents up to approximately 0.5 volume percent, after which further additions caused a slight decrease in strength. The strongest alloys contained equiatomic amounts of carbon and hafnium. The 3500°F (2200°K) tensile strength for swaged material was linearly related to the inverse square root of the cell size. Limited tensile and microstructural studies indicated that the W–Hf–C alloys are heat treatable. The stress for a 3500°F (2200°K), 100-hour rupture life was approximately 14,000 psi (96.5×10^6 N/m^2) in the swaged condition. A solution-annealed and aged specimen tested in 3500°F (2200°K) step-load creep tests required a stress of approximately 20,000 psi (138×10^6 N/m^2) for a minimum creep rate of 6×10^{-7} sec^{-1}, corresponding to an approximate 100-hour rupture life. These W–Hf–C alloys exhibit a sevenfold strength improvement over unalloyed tungsten at 3500°F (2200°K) that is related to the precipitate stabilized, fine dislocation structure formed within the cell boundaries. For high strength applications at 3500°F (2200°K), compositions composed of equiatomic amounts of carbon and hafnium, approximately 0.3 to 0.4 atomic percent, are recommended. Author

N68-17338*# Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF PROTECTIVE COATINGS FOR CHROMIUM-BASE ALLOYS
D. N. Williams, R. H. Ernst, C. A. MacMillan, J. J. English, and E. S. Bartlett 5 Mar. 1968 154 p refs
(Contract NAS3-7612)
(NASA-CR-54619) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Metallic cladding systems were applied to a chromium 5 weight percent tungsten alloy by gas-pressure bonding. Resistance to oxidation and nitrogen absorption during cyclic oxidation for up to 600 hours at 2100 and 2300°F were measured. Bend properties after oxidation exposures were determined. Multicomponent cladding systems were examined. The outer oxidation resistant layer consisted of 5 to 10 mils of Ni-30 weight percent Cr or of 5 mils of aluminized (5 weight percent) Ni-30 weight percent Cr or Ni-20 weight percent Cr-20 weight percent W. Barrier layers of W, W-25 weight percent Re, W-1 weight percent ThO_2, and Mo, 0.5 to 2.0 mils thick, were placed between the nickel alloy and the chromium alloy to retard interdiffusion. Compatibility layers of platinum or vanadium foil between the nickel-base alloy and the barrier layer were used in some systems. None of the systems provided adequate protection. Embrittlement of the chromium alloy occurred during cyclic oxidation. Contamination apparently occurred by diffusion of metallic elements through the barrier or cracks in the barrier layer during cyclic oxidation exposure. Diffusion of nickel into the chromium is suspected. Diffusion of chromium into the cladding material, thereby increasing the tungsten content of the chromium alloy, may also have been a factor. Thermal instability, tentatively attributed to chromium loss and surface enrichment in tungsten, was observed in the chromium alloy heated to 2100 or 2300°F in argon and may also have contributed to poor bend ductility. Author

N68-17372*# TRW Equipment Labs., Cleveland, Ohio. Materials Research and Development Dept.
GENERATION OF LONG TIME CREEP DATA OF REFRACTORY ALLOYS AT ELEVATED TEMPERATURES
Final Report, Jun. 26, 1963–Feb. 15, 1967
J. C. Sawyer and E. A. Steigerwald 6 Jun. 1967 197 p refs
(Contract NAS3-2545)
(NASA-CR-93193; ER-7203) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Creep tests were conducted on selected refractory alloys in a vacuum environment ($<1 \times 10^{-8}$ torr) for times between 100 and 15,000 hours. Since the ultimate program goal was to provide design data for space electric power systems, particular emphasis was placed on measuring creep extension below 1%. The resulting data were evaluated in terms of the relative properties of columbium, molybdenum, tantalum, and tungsten-base alloys. Larson–Miller and Manson–Haferd techniques were used to present the data in parametric form. In the 1800°F (982°C) to 2200°F (1204°C) temperature range, the molybdenum-base alloys TZC and TZM possess the best creep properties for the potential turbine applications. The variability of the creep properties as a function of heat of material was determined for the T-111 alloy. In addition

to comparison of alloy creep properties, chemical analysis, metallography, and tensile test data are presented to characterize each of the materials before and after creep testing. Author

N68-17377* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
COATINGS AND SURFACE TREATMENTS FOR LONGTIME PROTECTION OF Ti-8Al-1Mo-1V ALLOY SHEET FROM HOT SALT STRESS CORROSION
Bland A. Stein, H. Benson Dexter, and Dick M. Royster Washington Mar. 1968 51 p refs
(NASA-TN-D-4319) CFSTI: $3.00 CSCL 11F

After longtime exposures at 600°F in air at sea-level atmospheric pressure, the coatings were electroplated nickel with black nickel overcoat for high emittance, electrophoretically deposited aluminum, and a dipped coating of polyimide resin. The surface treatments included a vibratory treatment and glass-bead peening. The study included both residual-stress and self-stressed specimens which were dipped in a 3.4-percent NaCl solution, dried and exposed at 600°F (590°K) in circulating air ovens. Relative deflection measured in room-temperature bend tests or relative shortening measured in compression tests were used as quantitative indicators of stress-corrosion cracking in the specimens. An electron probe microanalyzer was used to determine interdiffusion between coating and substrate. The results indicated that the nickel and aluminum coatings were effective in preventing hot-salt stress corrosion for at least 10,000 hours exposure, whereas the polyimide coating peeled off the surface after 500 hours exposure. The glass-bead-peening process appeared to be effective in preventing or alleviating hot-salt stress corrosion for at least 10,000 hours. The vibratory treatment process proved to be effective in preventing or alleviating hot-salt stress corrosion for exposures of 15,000 hours when specimens were treated for at least 26 hours after fabrication. Author

N68-17484*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE INFLUENCE OF CRYSTAL STRUCTURE, ORIENTATION AND SOLUBILITY ON THE ADHESION AND SLIDING FRICTION OF VARIOUS METAL SINGLE CRYSTALS IN VACUUM (10^{-11} TORR)
Donald H. Buckley Washington 1968 31 p refs Presented at Symp. on Adhesion Sponsored by ASTM and Am. Soc. Lubrication Engr., Toronto, 1–2 May 1967
(NASA-TM-X-52246) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Friction and adhesion characteristics were measured in vacuum (10^{-11} Torr) for various metal single crystals. The (100), (110) and (111) planes of copper, the (111) plane of nickel, the (0001) plane of cobalt and the (110) plane of tungsten were studied. Experiments were conducted with matched planes and directions in contact, as well as mismatched orientations of copper. The (111) plane of copper was also examined in contact with nickel, cobalt and tungsten crystals. Measurements included: adhesion before sliding, friction during sliding and adhesion after sliding. The results indicate that sliding markedly increases the adhesion of clean metals in contact. The friction and adhesion of copper is highly anisotropic. Adhesion was observed for the insoluable couple copper–tungsten after sliding. Crystal structure was found to influence adhesion and friction. Author

N68-17591*# Bendix Corp., Detroit, Mich.
OXIDATION RESISTANT MATERIALS FOR TRANSPIRATION COOLED GAS TURBINE BLADES. 1: SHEET SPECIMEN SCREENING TESTS
Fred W. Cole, James B. Padden, and Andrew R. Spencer Washington NASA Feb. 1968 146 p
(Contract NAS3-7269)
(NASA-CR-930) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Twelve alloys were tested in sheet metal form to compare their suitability for use as transpiration cooled gas turbine blade materials. The alloys were N 155, TD nickel, TD nickel-chromium, Bendel 65-35, Chromel A, DH 242, GE 1541, Hoskins 875, RA 333, Hastelloy X, Udimet 500, and Haynes 25. Screening tests consisted of cyclic furnace oxidation at 1400°, 1600°, 1800°, 2000°, 2100°, and 2200°F for 4, 16, 64, 100, 200, 300, 400, 500, and 600 hours exposure time. Total oxidation and spalling were determined for each specimen along with variation in room temperature mechanical properties and microstructure. Electron beam welding feasibility was also investigated. Three best-compromise alloys were selected for later testing as wires to determine suitability for manufacturing space-wound or woven porous transpiration cooling materials. Author

N68-17616*# American Optical Co., Pittsburgh, Pa. Space Defense Group.
STUDY OF THE USE OF 304L STAINLESS STEEL AS AN OPTICAL REFLECTING ELEMENT Final Report
[1967] 11 p
(Contract NAS5-9631)
(NASA-CR-93289; FR-2259) CFSTI: HC $3.00/MF $0.65 CSCL 11F

This is an addendum to the final report on the use of 304L Stainless Steel as an uncoated, optical reflecting element. During this study, 304L Stainless Steel was successfully polished and figured to $\lambda/4$ and its temperature and stress stability determined. Similar work was previously done with four aluminum alloys, nickel, beryllium, and Haynes 25. Author

N68-17624*# Westinghouse Electric Corp., Lima, Ohio.
PROPERTIES OF MAGNETIC MATERIALS FOR USE IN HIGH-TEMPERATURE SPACE POWER SYSTEMS
P. E. Kueser, D. M. Pavlovic, D. H. Lane, J. J. Clark, and M. Spewock Washington NASA 1967 325 p refs
(Contract NAS3-4162)
(NASA-SP-3043) GPO: HC $2.25; CFSTI: MF $0.65 CSCL 11F

Test data are given and evaluated for eight magnetic materials that were found suitable for use in high-temperature liquid alkali-metal system applications. In general, the magnetic materials tested can be grouped in three temperature ranges, together with their fields of application: (1) 600° to 800°F: Most materials qualify for this temperature range. However, Cubex alloy (3-1/4% Si–Fe, doubly oriented) is preferred for use in stators at inductions up to 18 kilogauss. H-11 steel (5%Cr, 1%Mo, Fe) and maraging steel (15–18% Ni, 8–9% Co, Fe) are recommended for rotors, and Supermendur (2% V, 49% Co, 49% Fe) in controls using high quality, saturable-core reactors. (2) 800° to 1100°F: Hiperco 27 alloy (27% Co, Fe) is suggested for high inductions and Cubex alloy for inductions up to 15 to 18 kilogauss in stators. In rotors, H-11 steel qualifies for lower temperatures and Nivco alloy (approximately 72% Co, 23% Ni) for the higher temperatures in this range. (3) 1100° to 1400°F: Hiperco 27 alloy is recommended for stators and Nivco alloy for rotors in this temperature range. Author

N68-17626# Central Electricity Generating Board, Berkeley (England).
THE EROSION RESISTANCE OF STEAM TURBINE BLADE AND SHIELD MATERIALS
D. W. C. Baker, D. E. Elliott, D. G. Jones (Assoc. Elec. Ind., Ltd., Manchester (England)), and P. Pearson [1967] 71 p

Erosion tests have been carried out, using a wheel and spray apparatus, on a range of established and potential steam turbine low pressure blade and shield materials. Results are presented, in terms of both mass loss and volume loss for tests carried out at an impact velocity of 310 m. sec.$^{-1}$ using a water spray of drops of 660 μm mean diameter on the following materials: (1) cobalt-chromium base alloys; (2) turbine blade steels; (3) high speed tool and high strength steels; (4) miscellaneous steels; (5) titanium alloys; and (6) cemented tungsten and titanium carbides. The relationship between erosion resistance and the

composition, phase constitution, mechanical properties and condition of the materials is discussed. Particular reference is made to the significance of the production route on the erosion resistance exhibited by the cobalt-chromium alloys and the high speed tool steels. Author

N68-17654*# Syracuse Univ. Research Inst., N. Y. Chemical Engineering and Metallurgy Dept.
ADHESION BETWEEN ATOMICALLY PURE METALLIC SURFACES, PART 4 Semiannual Report
D. V. Keller, Jr. and T. McNicholas Jan. 1968 76 p refs
(Grant NsG-483-1)
(NASA-CR-93248; MET-1100-6801-SA, Pt. 4) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The metallic adhesion characteristics of an iron-65ppm carbon couple were investigated using the technique of Johnson and Keller which was refined by a continuous recording of the contact resistance and load data on an x–y recorder. Contact resistance results approximate closely theoretical curves which consider surface asperity phenomena. Bulk metallic adhesion was not characteristic of the system; to explain this, a model of carbon contamination of the surface by bulk diffusion is suggested. Creep processes found in the plastic range of the asperities are outlined and found to be in agreement with bulk plastic values. Author

N68-17660# Naval Research Lab., Washington, D. C.
PREPARATION AND CHARACTERIZATION OF ULTRA-PURE SOLIDS Annual Report, 1 Jul. 1966–30 Jun. 1967
C. C. Klick, G. T. Rado, M. R. Achter, and A. I. Schindler 1967 79 p refs
(ARPA Order 418)
(NRL-MR-1815; AD-663891)

Alkali halide crystals and glasses; Transition metal and intermetallic compound single crystals; Magnetic materials; Refractory metal crystals. TAB

N68-17678# Naval Research Lab., Washington, D. C.
FRACTURE PROPERTIES OF QUENCHED AND TEMPERED STEEL WELDMENT SPECIMENS Interim Report
L. J. McGeady 10 Oct. 1967 18 p
(NRL-6602; AD-663558)

Three test procedures were used to evaluate weldability features in seven Q and T steels. Two tests, the drop-weight bulge (DWB) test and the delta specimen test, used relatively large plate specimens containing full-thickness, multiple-pass welded joints. The loading system imposed in testing allowed fracture in them to follow a path of natural least resistance without bias from the loading direction. The third test, the drop-weight test (DWT), was used to determine the nil-ductility transition (NDT) temperature of the HAZ in the seven Q and T steels. The results from the three test methods indicated varying degrees of sensitivity of the HAZ to welding in the seven steels. The DWB and delta specimen results were quite similar and in general agreement. The DWT demonstrated that it was possible to measure an NDT for the HAZ (except in one steel, the high alloy or rich analysis steel, which did not fail in the HAZ). The NDT temperatures in the HAZ of the six steels were significantly higher than the NDT temperatures for the parent plate, suggesting that such measurements may possibly be useful for positioning of the fracture analysis diagram (FAD) to allow for fracturing which might occur in paths lower in toughness than the base plate. The work suggests that drop weight tear test (DWTT) energy measurements in the weld HAZ of high-strength steels should be attempted. Author (TAB)

N68-17860# RAI Research Corp., Long Island City, N. Y.
RESEARCH STUDY OF DIFFUSION BONDING OF REFRACTORY MATERIALS, COLUMBIUM AND TANTALUM Final Report, 22 Sep. 1966–21 Sep. 1967
Samuel Korman, Preston Keusch, Carlos Gonzalez, and Vincent D'Agostino Watertown, Mass. Army Mater. and Mech. Res. Center 10 Nov. 1967 37 p refs
(Contract DAAG-46-67-C-0020)
(RAI-385; AMMRC-CR-67-15(F); AD-663846)

The bonding of columbium and tantalum to themselves and to each other was observed under conditions of temperature, pressure, and presence of filler metal, wherein the controlling process is predominantly diffusion-controlled, as distinguished from pressure bonding, yield stress-controlled bonding, or creep-controlled bonding. For example, at 2000 psi and 419C.--a pressure well below the yield point of the parent metals and a temperature below their recrystallization points--all three combinations of parent metals could produce good lap-bonds with aluminum foil in 1/2 hr. At the same condition no bonds were obtained without foil in two hours. Butt-bonded joints under the same conditions exhibited tensile strengths of 12,000 psi for columbium and 19,850 psi for tantalum, with relatively poor joint efficiency as noted after rupture by the relatively small fraction of available contact areas. Results were obtained well below the observed recrystallization temperatures (600C. for columbium, and 800C. for tantalum). Evidence of oxidation was correlated with interference with bonding efficiency. It is believed that stricter atmosphere control and surface cleanliness related thereto could improve the joint strength and bond efficiency, even without reference to optimization of other process parameters. Author (TAB)

N68-17879# European Atomic Energy Community, Petten (Netherlands). Materials Dept.
ELECTRON MICROSCOPE STUDY OF OXYGEN INTERSTITIAL ORDERING IN VANADIUM
M. Cambini, M. Heerschap, and R. Gevers Nov. 1967 28 p refs
(EUR-3642.E) CFSTI: HC $3.00/MF $0.65

Results of an electron-microscope study on the annealing of cold-rolled vanadium are presented. The observations are ascribed to the dissolution and the ordering of oxygen interstitial impurities in the vanadium matrix. In particular, the body centered tetragonal Vanadium-Oxygen solid solution (β-Vanadium) revealed a twinned structure, the twinning plane being a $|110|$ original vanadium matrix plane. From the strong tetragonality and from superlattice diffraction data it is concluded that the oxygen interstitial atoms in this phase are in octahedral cavities and ordered in such a way that vanadium matrix planes containing interstitials are alternated with empty ones along only one of the six possible $<110>_V$ directions in a given domain. Domain walls separating two domains such that in each domain the ordering of the interstitial oxygen atoms has occurred along a different set of $|110|$ planes have been found lying approximately along $|100|_V$ planes. Author

N68-17897*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF LONGTIME ENVIRONMENTAL EXPOSURE ON MECHANICAL PROPERTIES OF SHEET MATERIALS FOR A SUPERSONIC TRANSPORT
Richard A. Pride, Dick M. Royster, Bland A. Stein, and James E. Gardner Washington Mar. 1968 26 p refs Presented at the Met. Soc. Session of the 96th Ann. Meeting of the Am. Inst. of Mining, Met. and Petrol. Engr., Inc., Los Angeles, 19–23 Feb. 1967
(NASA-TN-D-4318) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Studies of the effects of longtime environmental exposure on mechanical properties of supersonic transport sheet materials have been conducted by the Langley Research Center. These materials include titanium alloys, stainless steels, aluminum alloys, and a composite. Titanium alloys and stainless steels have been investigated since 1961, and results have shown that exposures of 30,000 hours at 550°F (561°K) have had little effect on the strength characteristics. Hot-salt stress corrosion occurs in titanium alloys under certain combinations of stress, temperature, and time but does not appear to be a problem at the operating conditions

of a Mach 2.7 supersonic transport. Aluminum alloys were investigated to provide materials information for the Mach 2 speed range and have been found to be temperature limited by longtime creep strength. Properties of the polyimide-resin–glass-fiber composite have been determined after 4000 hours exposure. This material appears to be suitable for extended use in a Mach 2.7 supersonic transport. Author

N68-17906# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

ANODIC POLARIZATION BEHAVIOR OF NICKEL 270 IN H_2-SATURATED, IN H_2SO_4

James R. Myers 1967 74 p

(AFIT-TR-67-6; AD-663922)

Results are given of a round-robin potentiostatic anodic polarization test program for pure nickel in hydrogen-saturated, 1N H2SO4 at 25C using the experimental technique usually used in each participants laboratory. TAB

N68-17956# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.

THE EFFECT OF SPECIMEN SIZE AND INTERFACE LUBRICATION ON THE COMPRESSIVE FLOW STRESS OF COPPER AND STEEL Technical Report, May 1966–Mar. 1967

Charles S. Cook and Joseph W. Spretnak (M.S. Thesis—Ohio State Univ.) Nov. 1967 46 p refs

(AFML-TR-67-280; AD-663426)

Test variables were examined to determine their significance in the cylindrical compression test with overhanging dies. The variables investigated were specimen diameter-to-height ratio (D/H) and interface lubricants for OFHC copper and AISI 1018 steel. For the purpose of evaluating the compressive flow curves, specimens 2.0, 2.5, and 3.0 inches in diameter, and 2.0 to 5.0 inches high were forged in a 500-ton forge press. Tensile flow was also examined for AISI 1018 steel. For the purpose of evaluating the behavior of interface lubricants, specimens 2.0, 2.5, and 3.0 inches in diameter, and 0.67 inch high were forged. Smaller copper specimens with dimensions proportional to those above were pressed in a 200,000-pound laboratory testing machine. Finally, the relative ranking of lubricants determined by pressing short specimens was compared to that determined by the ring compression test. Generally, the compressive flow stress of steel at 1800F with little or no influence of end effects was determined using specimen D/H values of approximately 0.6 or less. The evaluation of interface lubricant was satisfactorily examined using specimen D/H values of 3.0 or greater. The test, however, was sensitive to specimen diameter as well as lubrication. Thus, the relative rank of lubricants was altered somewhat by specimen diameter. The results failed to follow theoretically predicted behavior of applied pressure versus specimen D/H assuming either constant shear stress or constant coefficient of friction at the interface. Author (TAB)

N68-18131*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.

DEVELOPMENT OF DISPERSION STRENGTHENED TANTALUM BASE ALLOY Quarterly Progress Report, 20 Feb.–20 May 1967

R. W. Buckman, Jr. and R. C. Goodspeed 20 May 1967 27 p refs

(Contract NAS3-2542)

(NASA-CR-72326; WANL-PR-(Q)-015; QPR-14) CFSTI: HC $3.00/MF$0.65 CSCL 11F

Development of dispersion strengthened tantalum base alloys for use in advanced space power systems continued as the evaluation of 0.04 inch thick Ta–7W–1Re–1Hf–0.012C–0.012N sheet was essentially completed. Ductile-brittle transition temperatures of tungsten inert gas welded tantalum base alloys were determined as a function of longer post-weld annealing times than previously studied. The results were related to microstructure, phase morphology, and hardness data. Investigation of the effects of grain size on the creep properties of Ta–8W–1Re–1Hf and Ta–8W–1Re–0.7Hf–0.025C was continued. Initial results show that the creep properties of the alloys when recrystallized to 0.03mm grain size were independent of the final annealing temperature. Author

N68-18145*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

DEVELOPMENT OF A COBALT-TUNGSTEN FERROMAGNETIC, HIGH-TEMPERATURE, STRUCTURAL ALLOY

Richard L. Ashbrook, Anthony C. Hoffman, Gary D. Sandrock, and Robert L. Dreshfield Washington Mar. 1968 44 p refs

(NASA-TN-D-4338) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Rotors for space power generators require a compromise between high-temperature strength and magnetic properties. Rotors must withstand high centrifugal stresses at high temperature and develop high induction for small exciting fields. Alloys considered for rotors include maraging steels, H-11 steel, and a cobalt-base alloy, Nivco. This report discusses work to develop alloys with improved high-temperature strength and good high-temperature magnetic properties. Because cobalt has the highest Curie temperature of any metal and is a good base for high-temperature alloys, a NASA superalloy, cobalt–25 tungsten–1 titanium–1/2 zirconium–1/2 carbon was chosen for further study. Modifications of this alloy were screened for maximum magnetic induction B_{max} at a maximum magnetizing force H_{max} of 100 oersteds (7958 A/m) over a range of temperatures. Below 1000°F (538°C), low tungsten alloys show inflections in a plot of B_{max} as a function of temperature due to the instability of the face-centered cubic (fcc) phase. Stability of the fcc increased with increasing tungsten and iron. A preferred alloy, Co–7-1/2W–2-1/2Fe– 1Ti–1/2Zr–1/2C, was evaluated for magnetic and mechanical properties in cast form and for mechanical properties as sheet. After aging at 1700°F (927°C) for 72 hours, this alloy had a coercive force of 10.5 oersteds (835 A/m) at 75°F(24°C), and a B_{max} of 11.5 and 10.3 kilogauss (1.15 and 1.03 T) at 1200° and 1400°F (649° and 760°C), respectively. The stress-rupture life at 1200° to 1400°F (649° to 760°C) was greater than that of the strongest high-temperature commercially available magnetic-structural alloy. Author

N68-18166*# Syracuse Univ. Research Inst., N. Y. Dept. of Chemical Engineering and Metallurgy.

CREEP AT ELEVATED TEMPERATURES AND HIGH VACUUM

K. Schroeder, A. Giannuzzi, and G. Gorsha Dec. 1966 13 p refs

(Grant NsG-619)

(NASA-CR-81721; Met.E-1189-1266-SA; SAR-5) CFSTI: HC $3.00/MF$0.65 CSCL 11F

Creep tests in high vacuum and elevated temperatures were continued on copper of 99.9% purity and silver of 99.999% purity. The testing procedure was unchanged, and the experimental results were analogued to previously obtained data: the minimum creep rate decreased, if an initially argon bombarded and tested sample was annealed in air and retested in the same vacuum and temperature. Such results are surprising. A silver sample should interact at elevated temperatures with air quite differently than copper, because silver oxide is not stable in our testing conditions, whereas copper samples showed quite strong oxide films. It is therefore more likely, that the reduction of the creep rate is not due to an oxide film. It is more likely associated with the absorption of oxygen in the sample, where it may either harden grain boundaries, retard the operation of dislocation sources, or increase frictional forces on moving dislocations. It is also possible that a partial oxygen monolayer could interfere with slip line formation. Author

N68-18180# Brown Univ., Providence, R. I. Div. of Engineering.
AN EXPERIMENTAL STUDY OF THE STRENGTHENING MECHANISM AND FRACTURE BEHAVIOR OF SPHEROIDIZED CARBON STEELS
Chain-tsuan Liu Aug. 1967 145 p refs
(Contract AT(30-1)-2394)
(NYO-2394-28; TR-28) CFSTI: HC $3.00/MF $0.65

The effects of grain boundaries and carbide particles on the strengthening mechanism and fracture behavior of spheroidized carbon steels ranging in carbon content from 0.065 to 1.46% are investigated. The spheroidized structure of the steel was obtained by quenching and tempering. The specimens were tested in tension to fracture at room temperature. The Petch type of strength-structure parameter equation is applied to the yield and flow properties of spheroidized carbon steels on the basis of different effective structural barriers in the various ranges of composition and strain. The mechanical behavior of low carbon steels (0.065 and 0.30%C) is similar to that of polycrystalline iron and the Petch form of the strength-grain size relation has been found to be equally applicable to both the yield and flow stresses. In medium and high-carbon steels (0.55 to 1.46%C), the strength data also satisfy the Petch equation based, however, on the particle spacing, which is believed to be associated with the dimensions of a dislocation cell structure formed during heat treatment and strengthened by deformation. A simplified model describing the fracture behavior of the medium and high carbon steels is proposed, which predicts that the fracture strength is inversely proportional to the square root of the slip distance, i.e., the particle spacing. The experimental data are in agreement with the predicted variation of fracture strength with the slip distance available in these steels. Author (NSA)

N68-18200# Naval Radiological Defense Lab., San Francisco, Calif.
EROSION–CORROSION OF HAYNES-25 ALLOY; RADIOACTIVE TRACER TECHNIQUES
Herman I. Cordova and Donald A. Kubose 10 Jan. 1968 25 p refs
(Contract AT(49-5)-2084)
(USNRDL-TR-67-142; AD-663566)

The erosion-corrosion caused by the washing of a mixture of seawater and ocean-bottom material across a specimen of Haynes-25 at ambient room temperature was studied with radioactive tracer techniques. The results obtained under the conditions of this study showed that the corrosion rate in such an environment increased 4 orders of magnitude over that observed in seawater alone. Author (TAB)

N68-18207 Central Inst. for Industrial Research, Blindern (Norway).
SUPPORT EVALUATION CONFERENCE ON HIGH TEMPERATURE MATERIALS
N. E. Promisel, ed. 5 Aug. 1967 180 p Held in Sandfjord, Norway, 31 Jul.–5 Aug. 1967 Sponsored by NATO Sci. Comm.

CONTENTS:

1. INTRODUCTORY REMARKS N. E. Promisel 14 p (See N68-18208 08-17)
2. EXTERNAL CHEMICAL REACTIONS 35 p (See N68-18209 08-17)
3. INTERNAL REACTIONS AND STABILITY 14 p (See N68-18210 08-17)
4. DEFORMATION AND PROCESSING 14 p (See N68-18211 08-17)
5. ATOMIC STRUCTURE AND CORRELATION WITH BEHAVIOUR 15 p (See N68-18212 08-17)
6. ALLOYING PRINCIPLES AND STRENGTHENING MECHANISMS 27 p (See N68-18213 08-17)
7. TECHNIQUES OF RESEARCH 8 p (See N68-18214 08-17)
8. AN IMPORTANT PROGRAMME FOR COOPERATIVE RESEARCH ON REFRACTORY METALS 3 p (See N68-18215 08-17)

N68-18208 Central Inst. for Industrial Research, Blindern (Norway).
INTRODUCTORY REMARKS
N. E. Promisel *In its* Support Evaluation Conf. on High Temp. Mater. 5 Aug. 1967 14 p (See N68-18207 08-17)

Major high temperature applications are listed, with propulsive system and structural usages identified as the most important. Four basic ways of coping with high temperatures are cited as cooling, insulation, thermal–physical phenomena, and temperature resistant materials. Candidate materials for extremely high temperatures are proposed. For the oxidizing environment, these include chromium alloys, hafnium–tantalum alloys, coated and clad refractory metals (Mo, Cb, Ta, W), ceramic–metal combinations, and ceramics; for the inert environment, refractory metals (Mo, Cb, Ta, W), and graphite. Major problem areas are considered to be consolidation, fabrication and forming, joining, toughness, reproducibility, adequate design behavior, resistance to environment, and test techniques and equipment. Pertinent properties are characterized as stress-to-rupture, creep, fatigue, thermal shock, ductile to brittle transition, oxidation resistance, fabricability and joinability, resistance to molten metals, impact, erosion, and thermal, electronic, and nuclear characteristics. M.G.J.

N68-18209 Central Inst. for Industrial Research, Blindern (Norway).
EXTERNAL CHEMICAL REACTIONS
In its Support Evaluation Conf. on High Temp. Mater. 5 Aug. 1967 35 p (See N68-18207 08-17)

Reaction with gaseous environments is cited as the single greatest deterrent to the use of refractory metals in virtually all high temperature devices other than those operating in vacuum or an inert atmosphere, and specific areas in which technological advances in oxidation and protective coatings are needed are discussed. Consideration is given to the thermochemical properties which permit the calculation of the final state of equilibrium and defect structure in oxides, and to the reaction behavior of refractory metals and alloys with their environment. Oxidation resistance coating systems are discussed in terms of three different concepts: ductile metallic coatings, oxide or ceramic overlays, and intermetallic diffusion coatings. M.G.J.

N68-18210 Central Inst. for Industrial Research, Blindern (Norway).
INTERNAL REACTIONS AND STABILITY
In its Support Evaluation Conf. on High Temp. Mater. 5 Aug. 1967 14 p (See N68-18207 08-17)

Various aspects of solid state reactions are discussed, such as diffusion, the stability of precipitates, aging effects, stability of dislocation networks, and the role of point defects and solute atoms. The effect of all these different features of metallic behavior on the resultant microstructure is also considered. To ensure fabricability in refractory metals, it is pointed out that detailed knowledge is needed on recovery, recrystallization, and grain growth in order to avoid embrittlement. For conducting finer scale studies in the fields of precipitates and impurities, the recommendation is made for improving such techniques as field ion microscopy and the secondary emission ion probes. M.G.J.

N68-18211 Central Inst. for Industrial Research, Blindern (Norway).
DEFORMATION AND PROCESSING
In its Support Evaluation Conf. on High Temp. Mater. 5 Aug. 1967 (See N68-18207 08-17) 14 p

To reflect the need for meaningful relationships between details of structure and processing, attention focussed on six

topics: intergranular cracking of cast structures, cracking in sintered materials, grain size control, texture control, relationships between deformation and thermal processing in terms of fine structure, and toughness in relation to processing and structure. Research in each area is proposed, with highest priority recommended for investigations on the causes of intergranular fracture particularly in cast structures; the possibility of controlling grain size; the potential for improved properties in refractory metal sheet through changes in texture; the dislocation structure generated in single phase and multiphase refractory alloys under processing conditions of strain, strain rate, and temperature; fracture toughness qualities; and a quantitative study of the dislocation mechanisms of plastic relaxation around a propagating crack. M.G.J.

N68-18212 Central Inst. for Industrial Research, Blindern (Norway).
ATOMIC STRUCTURE AND CORRELATION WITH BEHAVIOUR
In its Support Evaluation Conf. on High Temp. Mater. 5 Aug. 1967 (See N68-18207 08-17) 15 p

The importance of the electronic structure of transition metals for technological properties is discussed, along with the need for expressing point defect properties in terms of enthalpy and entropy of formation and migration, and bonding energies of point defect clusters. The question of intrinsic and impurity controlled properties in refractory metals is considered, and a distinction is made between low, intermediate, and high temperatures, in which different processes control the dislocation movement. Research is recommended, with priority given to (1) obtaining independent values for vacancy formation and migration energies and to determining whether these results are compatible with accurately measured values of self-diffusion energies; (2) investigating the velocity of dislocations of specified orientation as a function of stress, temperature, crystal orientation, and direction of stressing, using the etch-pit technique; and (3) measuring the effects of temperature and stress on the creep rate of constant structure by abrupt temperature and stress changes. M.G.J.

N68-18213 Central Inst. for Industrial Research, Blindern (Norway).
ALLOYING PRINCIPLES AND STRENGTHENING MECHANISMS
In its Support Evaluation Conf. on High Temp. Mater. 5 Aug. 1967 (See N68-18207 08-17) 27 p

The difficulties associated with establishing alloying principles and strengthening mechanisms for refractory metals are identified, and the point is made that refractory metals technology is dependent on the scientific principles derived from other metals technologies. An overview is presented on such aspects of alloy strengthening as single phase solid solutions; terminal solid solutions for use to 1200°C, and above 1200°C; hexagonal close-packed intermediate solid solution alloys; carbide precipitation strengthening; oxide dispersion strengthening; and work hardening, recrystallization, and grain size. Consideration is also given to the problems involved in alloying and the ductile-brittle transition temperature, with recommendations made for further research on the rhenium effect, and improvement by means of a dispersed phase. Methods for strengthening refractory metals by the incorporation of high strength fibers are reviewed, and the possibilities of producing finished components in refractory metal alloys by casting to shape are assessed. Research recommendations are included in order of priority. M.G.J.

N68-18214 Central Inst. for Industrial Research, Blindern (Norway).
TECHNIQUES OF RESEARCH
In its Support Evaluation Conf. on High Temp. Mater. 5 Aug. 1967 (See N68-18207 08-17) 8 p

Areas where new techniques might greatly advance the ability to make rapid progress in the high temperature metal field are discussed, along with the possibilities of improving or enlarging present techniques to advance current capabilities. Attention is centered on the need for increased precision in thermochemical measurements at high temperatures, high resolution examination of microstructural and sub-microstructural features of metals and alloys, mechanical testing and strain measurements at temperatures above 1000°C, and physical testing and nondestructive tests of oxidation-resistant coatings. Also stressed is the urgent requirement for document dissemination of details on crystal structure, thermophysical, and thermodynamic data in all areas of refractory metal technology. M.G.J.

N68-18215 Central Inst. for Industrial Research, Blindern (Norway).
AN IMPORTANT PROGRAMME FOR COOPERATIVE RESEARCH ON REFRACTORY METALS
In its Support Evaluation Conf. on High Temp. Mater. 5 Aug. 1967 3 p (See N68-18207 08-17)

A cooperative research program between laboratories and universities in NATO countries is suggested. The recommendations cover studies of reactions of gases with refractory metals and alloys and means of protecting the metals against such deterioration; properties of refractory metal silicides, aluminides, and other compounds used as protective coatings; diffusion in these compounds and in oxides which serve as protective scales; and compatibility and interdiffusion of coating layers with substrate metal. M.G.J.

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N68-17261# Los Alamos Scientific Lab., N. Mex.
CMF-13 RESEARCH ON CARBON AND GRAPHITE Summary Progress Report, 1 Aug.–31 Oct. 1967
Morton C. Smith 15 Nov. 1967 24 p refs
(Contract W-7405-ENG-36)
(LA-3821-MS; Rept.-3) CFSTI: HC $3.00/MF $0.65

An investigation of techniques for deagglomerating and preparing carbon black samples for electron micrography and particle counting is being made. Helium pycnometer densities were determined for 13 cokes, 8 graphite flours, 5 ground pyrolytic graphites and 1 carbon black. Surface area analyses were completed on 7 samples of YBF graphite. An attempt is being made to predict mixing ratios that will increase the densities of extruded graphite rods. Several resins were made by polymerization of furfuryl alcohol. Grinding studies are being carried out on graphite. Estimations of optimum binders concentration in graphite production are discussed. Effects of resin properties on the properties of resin-bonded graphites are described. Studies of the structure of solid raw materials, intermediate products, and manufactured carbons and graphites are reviewed. Effects of prior creep strain on the activation energy for tensile creep of graphite, compressive creeps of graphite, and creep of zinc are considered. Thermal expansion, thermal conductivity, and swivelling of graphite are discussed. NSA

N68-17312# Weapons Research Establishment, Salisbury (Australia).
THE EFFECT OF FILLER CONTENT ON THE GLASS TRANSITION TEMPERATURE AND GLASSY MODULUS OF A POLYURETHANE RUBBER
R. J. Wiles Jun. 1967 19 p refs
(WRE-TN-CPD-113)

The effects of filler content on the glass transition temperature and glassy state modulus of a polyurethane rubber has been investigated using a Clash and Berg torsion test apparatus. In rubbers filled with inorganic glass beads, the glass transition temperature was found to increase linearly with filler content. The effect of ammonium sulphate as a filler was found to raise the glass transition temperature, but experimental scatter, probably due to dewetting, does not allow to determine the relation with certainty. The reinforcing effect of glass beads on the glassy state modulus appears to be greater than that of fine ammonium sulphate. Author

N68-17390*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
TENSILE CREEP STUDIES ON GLASSY CARBON
D. B. Fischbach. 1 Mar. 1968. 23 p. refs
(Contract NAS7-100)
(NASA-CR-93203; JPL-TR-32-1228) CFSTI: HC $3.00/MF $0.65
CSCL 11B

The tensile creep behavior of glassy carbon has been investigated for two grades of Japanese glassy carbon, GC-20 and GC-30, which were heat-treated to maximum temperatures of 2000° and 3000°C. The reduction in cross-sectional area of GC-30 was nearly that predicted for constant volume deformation; the reduction in area of GC-20 was a little smaller. A stress-change technique was used to determine the dependence of the isothermal creep rate on elongation at various stress levels. The creep rate decreased monotonically with elongation under constant load and temperature. Tensile elongation produced a definite preferred orientation texture in the initially isotropic carbon. Creep recovery occurred when the stress was reduced. A temperature-change technique at constant load was used to determine the dependence of creep rate on elongation at various temperatures. The effective activation energy determined from these data is 350±40 kcal/mole over the range 2500°–2900°C and 6000°–16,000 psi. Author

N68-17424*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
EFFECTS OF ATMOSPHERIC REENTRY ON GRAPHITE PARTICLES
M. J. Engel, B. B. Hamel, J. W. Metzger, E. J. Nolan, S. M. Scala et al. Jan. 1964. 308 p. refs
(Contracts SNPC-10; AT(40-1)-2847)
(NASA-CR-93257; TID-23786) CFSTI: HC $3.00/MF $0.65
CSCL 11B

A theoretical and experimental investigation was conducted on the oxidation behavior of two materials, ATJ graphite and a reactor material of special interest. The oxidation behavior was predicted for both reaction rate controlled and diffusion controlled oxidation for low Reynolds number (Re) continuum flow and molecular flow, and for the transition on regime between these two flows. Behavior of the reacting surface is described in terms of drag, heat transfer, and mass transfer for these flow conditions which correspond to very high altitudes. Correlation with shock Re was established for both reaction rate and diffusion controlled oxidation. Experimental results agreed with theoretical predictions on the shape change behavior of spherical specimens of the materials. Mass loss data were obtained. Computations determined that all particle sizes investigated would readily survive the selected reentry environments. NSA

N68-17633# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie.
QUASIBINARY PHASE DIAGRAMS OF THE SYSTEM THULIUM OXIDE–ACTINIDE OXIDE (ThO_2, UO_2, NpO_2, PuO_2) BELOW 1700°C [QUASIBINAERE PHASENDIAGRAMME DER SYSTEME THULIUMOXIDE–ACTINIDENOXID (ThO_2, UO_2, NpO_2, PuO_2) UNTERHALB 1700°C]
Lutz Leitner. Feb. 1967. 86 p. refs. In GERMAN
(KFK-521)

In the system ThO_2–$TmO_{1.5}$ the temperature dependence of the limiting composition of the individual phases was determined by x-radiographic methods. The phase diagram at 1250 to 1700°C was constructed. The ir spectra of mixed oxides of the various phase regions were obtained. The expansion coefficients α of a mixed oxide (7.5 mol % $TmO_{1.5}$) were determined as $\alpha = 8.0\times10^{-6}$/°C at 25 to 1250°C and that of Tm_2O_3 as $\alpha = 8.6\times10^{-6}$/°C at 25 and 1200°C. The integral heats of solution of the solutions of $MeO_{1.5}$ (Me = Ho, Tm, Lu, and Sc) in ThO_2 and that of ThO_2 in $MeO_{1.5}$ were estimated. The phase diagrams of the system XO_2–$TmO_{1.5}$ (X = U, Np, Pu) at 1250 and 1550 or 1700°C were constructed on the basis of the determination of the temperature dependence of the limiting composition. The rhombohedric $NpO_3 \cdot 6TmO_{1.5}$ compound has the following lattice parameter: a = 6.469 Å, α = 99.0, and rhombohedric mole volume = 259.51 $(Å)^3$. In the system $(U_x, Tm_{1-x})O_{2.00}$, a homogeneous cubic phase with the fluorite structure extends at 1240°C from 0 to 52.5 mol % $TmO_{1.5}$. The system UO_{2+x}–$MeO_{1.5}$ (Me = Tm and Yb), the temperature dependence of the fluorite phase, which extends up to 60 mol % $MeO_{1.5}$ was investigated. In the system UO_{2+x}–$TmO_{1.5}$ ir spectra of individual mixed oxide preparations from the various phase regions were obtained. In the same system a homogeneous rhombohedric phase was observed from 72 to 85.7 mol % $TmO_{1.5}$. The phase diagrams of both systems were constructed. The solubilities in the system XO_2–$TmO_{1.5}$ and the fluorite phase limits of UO_{2+x}–$MeO_{1.5}$ (Me = Tm and Yb) were tabulated. Author (NSA)

N68-17642# Sandia Corp., Albuquerque, N. Mex.
NOVEL FERROCENE POLYURETHANE
N. C. Fawcett, D. R. Anderson, and P. E. Cassidy. Sep. 1967. 16 p. refs. Presented at the Am. Phys. Soc. Meeting, Chicago
(Contract AT(29-1)-789)
(SC-DC-67-2060; CONF-670946-1) CFSTI: HC $3.00/MF $0.65

The formulation of semirigid polyurethane foams using 27 wt % 1, 1'-bis(α-hydroxyethyl)-ferrocene (BEF). Foam was obtained in two forms: nonoxidized and oxidized. Thermal and mechanical properties, along with other evidence, are offered in support of this oxidation. Possible inhibitions of oxidative degradation of the polymer backbone through sacrificial oxidation of ferrocine iron atoms is discussed. NSA

N68-17677# Naval Research Lab., Washington, D. C.
THE WETTABILITY OF ETHYL- AND VINYLTRIETHOXYSILANE FILMS FORMED AT ORGANIC-LIQUID/SILICA INTERFACES Interim Report
W. D. Bascom. 4 Dec. 1967. 26 p. refs
(NRL-6644; AD-663559)

Critical surface tensions and water contact angles were determined for adsorbed films of ethyltriethoxysilane and vinyltriethoxysilane on silica and alpha-alumina. The films were formed by retraction from hydrocarbon solution. Studies were also made of film resistance to desorption and alteration when in prolonged contact with water. The vinyltriethoxysilane films were generally more oleophobic and more hydrophobic than the films formed by the ethyl analog. The vinyltriethoxysilane films were also more resistant to disruption and desorption when contacted with water. Neither vinyl- nor ethyltriethoxysilane formed strongly held films on alpha-alumina. The addition of low-molecular-weight organic acids or bases to the adsorbate solutions resulted in both the ethyl-and vinyltriethoxysilane forming hydrophobic and water resistant films on silica and alpha-alumina. The results suggest that the adsorption process involves the adsorbate molecules reacting with silanol groups on the silica to form siloxane linkages to the surface and reacting with themselves to form adsorbed siloxane polymer. The properties of the resulting film will depend upon the number of surface attachments and the extent of crosslinking between adsorbate molecules. Author (TAB)

N68-17691# Department of Forestry, Vancouver (British Columbia). Forest Products Lab.
STRESS RELAXATION IN WOOD AT DIFFERENT GRAIN ANGLES

L. Bach and B. Rovner Jun. 1967 22 p refs
(VP-X-14)

An exploratory study of uniaxial compression stress relaxation of Douglas-fir was made to survey the relative influence of grain angle to direction of restraint. Fractional stress relaxation was found to increase with increasing grain angle. Author

N68-17736# Department of Forestry, Vancouver (British Columbia). Forest Products Lab.
A MODEL APPROACH TO THE CHANGE IN THE DC RESISTANCE OF WOOD INDUCED BY MECHANICAL STRESS
Lars Bach Sep. 1967 18 p refs
(VP-X-19)

In order to formulate the problem of conductivity in wood in electrokinetic terms, western red cedar wood specimens with 7.5% moisture content were examined experimentally by simultaneous exposure to mechanical stress and electrical fields. The mechanical stress field was applied parallel to the longitudinal axis of the specimens while the electrical field was applied in the radial direction perpendicular to the grain and direction of applied stress. Specimens were permitted to polarize at field intensity of 500 volt/inch for one hour prior to mechanical stress cycling. An assessment is made on the relation of tension stress parallel to the grain to a decrease in electrical resistance, resistance change for increasing and decreasing loads, and resistance when exposed to five consecutive cycles of mechanical stress. In comparing results with a simple model for both ionic and electronic conduction in a solid, an electrical resistance change of more than two times the strain between the electrodes was observed, indicating a change in intrinsic electrical conductivity. B.S.D.

N68-17764# Princeton Univ., N. J. Frick Chemical Lab.
MACROMOLECULAR RELAXATION IN THE DAMPED TORSIONAL OSCILLATOR AND STATISTICAL SEGMENT MODELS
Arthur V. Tobolsky and Donald B. DuPre Dec. 1967 50 p refs
(Contract Nonr-1858(07))
(ONR-TR-RLT-102; AD-663704)

The damped torsional oscillator models of polymer chain dynamics is compared with that of Rouse and Bueche where the basic responding unit is the statistical segment of approximately ten carbon-carbon links. The monomeric torsional oscillator approach appears to correspond better to physical reality for high frequency dielectric and nuclear magnetic resonance relaxations. Effects of coupling of torsional oscillators in not only one but also three dimensional arrays are discussed. Response of three dimensional quasi-lattices such as might occur with organic glasses is predicted to be much sharper than the one dimensional analog.
Author (TAB)

N68-17776# Naval Research Lab., Washington, D. C.
ENVIRONMENTALLY ASSISTED CRACK GROWTH IN GLASS
George M. Sinclair and Stephen P. Withrow 22 Nov. 1967 21 p refs
(NRL-6635; AD-663885)

Glass exhibits the properties of high compressive strength and low density. However, the surface of unprotected glass contains flaws which grow under low stress in moist conditions to critical size for failure. Various methods were used to investigate and increase the reliability of glass under stress. Data were obtained on failure of unprotected glass plates subjected to biaxial tension at about 50-percent relative humidity. Analysis by extreme-value statistics indicated that the failure condition could be represented by a plane surface in a three-dimensional coordinate system composed of extreme-value probability, log stress, and log time. Removal of surface flaws by etching in 5-percent aqueous hydrofluoric acid increased the mean failure strength from approximately 30,000 psi to 145,000 psi, with a value of 300,000 psi biaxial tension being attained in one case. Increases in lifetimes of one, two, and three orders of magnitude were obtained by protecting the glass from atmospheric moisture by preheating and coating with petrolatum, preheating glass and coating with preheated petrolatum, and experimenting at -30F, respectively. Slight improvement in minimum time to failure was obtained by eliminating the weaker specimens by proof testing. Author (TAB)

N68-17779# Naval Civil Engineering Lab., Port Hueneme, Calif.
AIRFIELD MARKING PAINTS. 4: EFFECT OF PAINT FLEXIBILITY ON SLURRY SEALED ASPHALT
Richard W. Drisco Dec. 1967 32 p refs
(R-556; AD-663562) CFSTI: HC $3.00/MF $0.65

A field exposure study was conducted on experimental airfield marking paints with relatively high flexibilities. While flexibility must be greater than the minimum required in Federal Specification TT-P-85b for good paint performance, a further increase in flexibility does not necessarily result in better performance. Short oil length alkyd and oleoresinous paints do not perform well; medium oil length paints performed very well; longer oil length paints generally performed somewhat poorer than medium oil length paints, especially for the alkyd formulations. While incorporation of organic plasticizers into paints generally increased flexibility, it did not usually improve the field performance. A statistical analysis of the test variables revealed the following: Oleoresinous phenolic varnish generally performed better than alkyd paint stripes. Lifting was greater for double-thickness thickness stripes than for single-thickness stripes. Cracking was faster for long oil than medium oil alkyd paints and for medium oil than for long oil oleoresinous paints. Medium oil paints had less cracking overall than long oil paints. There was generally less cracking and lifting with paints containing no plasticizer than those with one. Tricresyl phosphate formulations generally had less edge cracking and lifting than comparable formulations with dibutyl phthalate as a plasticizer. There was a high correlation between edge cracking and the lifting of slurry seal.
Author (TAB)

N68-17893# Princeton Univ., N. J. Frick Chemical Lab.
SOLID "LIQUID CRYSTAL" FILMS OF POLY-γ-BENZYL-L-GLUTAMATE
E. T. Samulski and Arthur V. Tobolsky Dec. 1967 8 p refs
(Contract Nonr-1858(07))
(ONR-TR-RLT-103; AD-663705)

Cast solid films containing rigid alpha-helical molecules exhibit a molecular structure similar to that found in the liquid crystalline phase. Optical measurements and anisotropic swelling of the films are interpreted in terms of a preferential orientation of the liquid crystalline structure in the film. Author (TAB)

N68-17910# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
EFFECT OF VACUUM ON THE STRENGTH OF BALSA WOOD
F. E. Blair, S. W. Johnson, and P. J. Torvik 1967 30 p refs
(AFIT-TR-67-4; AD-663920)

Previous investigations have shown that exposure to vacuum has little effect on the ability of balsa wood to absorb energy. Because this material has, in addition to its energy absorbing capability, a favorable strength to weight ratio and can be cut and shaped with ease, the use of balsa wood as load carrying members in space is a distinct possibility. In this investigation, specimens of oven-dry balsa were loaded to failure in either bending or compression after exposure to vacuums of 0.0001 to 0.00001 torr for periods as long as twelve days. Some specimens exposed to vacuum were tested in vacuum; others were tested in air. As controls, the strength properties of similar specimens which had not been subjected to vacuum were determined. The effect of vacuum on compressive and bending strengths was found to be negligible. A small weight reduction primarily due to a loss of moisture while in vacuum was observed, but no damage to the cellular structure of the wood was detected

when thin sections of exposed and unexposed wood were examined and compared under a microscope. Author (TAB)

N68-17932# Avco Corp., Lowell, Mass. Space Systems Div.
EFFECT OF THERMAL CONDITIONING AND STRAIN ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF ALUMINA Final Report
Edmund M. Passmore, Anthony Moschetti, Paul Burnett, and David Sellers Nov. 1967 66 p refs
(Contract DA-19-066-AMC-277(X))
(AVSSD-0441-67-RR; AMMRC-67-16(F); AD-663835)

Yielding and fracture in dense, pure, fine-grained aluminum oxide have been studied using stress-strain curves obtained from four-point bend tests by means of a bent beam plastic stress analysis. Transitions from brittleness to ductility in bending were shown to occur at temperatures from 1200C to 1400C. Yielding was found to be a thermally activated process, having an apparent activation energy of 59,000 cals/mole, similar to that for oxygen ion diffusion in alumina. The mechanism of plastic deformation was attributed primarily to stress enhanced diffusion in which the small grain size of the experimental material promoted ductility. Observations of grain boundary sliding and separation were also made. The effect of strain on the brittle fracture stress was investigated by prestraining specimens above the transition temperature and unloading, cooling, and testing to fracture below the transition temperature. It was found that for strains up to about 0.4% there was no significant effect on the fracture stress, but for higher prestrains, up to 1.5%, reduction of the brittle fracture stress, averaging about 30%, was observed. This weakening was believed to be caused by intergranular separation. The brittle fracture strength also appeared to decrease with increased porosity. Author (TAB)

N68-18019*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE STRUCTURE OF THE GRAIN BOUNDARY IN CERAMICS
E. C. de Wys and M. H. Leipold 15 Feb. 1968 16 p refs
(Contract NAS7-100)
(NASA-CR-93366; JPL-TR-32-1211) CFSTI: HC $3.00/MF $0.65 CSCL 11B

As part of a program to determine the role of the grain boundary in the behavior of polycrystalline ceramics, research has been conducted to directly observe the atomic structure and microstructure of the grain boundary in a typical polycrystalline ceramic (MgO). Various experimental techniques were considered and discussed, and preliminary results, using several techniques, were obtained. Termination of the entire effort prevented more complete findings and development of a useable model of grain boundary structure. However, the preliminary results did indicate extreme complexity in the grain boundary structure of the high-purity magnesium oxide samples. Advanced X-ray techniques and quantitative optical microscopy also appeared to be quite useful. Author

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N68-17234# Sandia Corp., Albuquerque, N. Mex.
PROBABILITY DISTRIBUTIONS FOR SUMS OF CERTAIN RANDOM VARIABLES, COMPARED TO THE GAUSSIAN APPROXIMATION
Glen W. Belden Nov. 1967 237 p refs
(SC-RR-67-799) CFSTI: HC $3.00/MF $0.65

The probability distribution functions are calculated for the sum of N independent and identically distributed random variables for several special cases. The sum of N random variables which can assume the values 1 and 0 with probabilities p and q = 1 − p has a binominal distribution which is shown herein for N = 2(1)10(5)25(25)100(50)300 and for p = 0.1, 0.2, 0.5, 0.8, 0.9. Also, the distribution of a sum of N random variables with a uniform probability density function from 0 to 1 shown for N = 2(1)10(5)20. A measure of the error caused by approximating the distribution of the sum by a Gaussian distribution of the same mean and standard deviation is given by graphs of the ratio of the actual distribution function to the Gaussian distribution function for the values of N listed above. Author (NSA)

N68-17275# Sandia Corp., Albuquerque, N. Mex.
ESTIMATION OF UNKNOWN PROBABILITY DENSITY FUNCTIONS FROM OBSERVED DATA
R. S. Printiss Sep. 1967 19 p
(Contract AT(29-1)-789)
(SC-DC-67-2118) CFSTI: HC $3.00/MF $0.65

A stochastic approximation algorithm is used to estimate the probability density function of a random variable where the only information is a set of independent samples (measurements) of the random variable. A computer program was written which computes a set of coefficients for a truncated sine series approximation of the probability density function and the average value and variance of the random variable; it then plots the results of each approximation, which gives a picture of the nature of the convergence of the approximation scheme. It is shown that stochastic approximation methods result in a minimum mean-squared error approximation of a variable when certain assumptions about the variable can be made. A comparison between a known function and this program's estimate of that function is made, and calculations of the mean-squared error between the two functions are given. Author (NSA)

N68-17290# Royal Aircraft Establishment, Farnborough (England).
A MATHEMATICAL METHOD FOR DETERMINING THE STABILITY OF MOTION OF A TUNING FORK GYROSCOPE
D. E. Williams Jun. 1966 11 p refs
(RAE-TR-66198)

A method for examining the stability of a tuning fork gyroscope is presented. In this method the rates of damping are found by using Floquet's theorem on a set of linear homogeneous differential equations with periodic coefficients. C.T.C.

N68-17334*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
BOUNDS FOR THE EIGENVALUES OF A MATRIX
Kenneth R. Garren Washington Mar. 1968 45 p refs
(NASA-TN-D-4373) CFSTI: HC $3.00/MF $0.65 CSCL 12A

This paper provides a listing of techniques used to determine the eigenvalue bounds of a matrix defined over either the real or complex fields. Theorems concerning the condition of eigenvalues as a function of the related matrix are stated. Known theorems which determine the bounds are derived. Closed-form solutions are expressed in terms of (1) the matrix elements, (2) matrix norms, and (3) vectors and the eigenvalues of related matrices. Extensions of several results are made to infinite matrices. A comparison is made in terms of the relative size of the areas of eigenvalue inclusion for the various solutions. Examples in terms of eigenvalue bounds for particular matrices are given. Author

N68-17438# Los Alamos Scientific Lab., N. Mex.
USING NONLINEAR LEAST-SQUARES METHODS FOR QUANTAL RESPONSE AND SENSITIVITY ANALYSES, MINIMUM CHI-SQUARE ESTIMATION, AND DIFFERENTIAL EQUATIONS
Roger H. Moore and R. Keith Zeigler 17 Nov. 1967 13 p refs
(Contract W-7405-ENG-36)
(LA-3763) CFSTI: HC $3.00/MF $0.65

A number of special statistical and mathematical techniques reduce to solving equations equivalent to those required by general

least-squares procedures. In the statistical category are quantal response and sensitivity analyses and minimum chi-square estimation of parameters; in the mathematical, is the problem of determining constants for differential equations whose solutions are relations among observable variables. This report contains demonstrations of the equivalences and provides examples to which the methods were applied. Author (NSA)

N68-17508# Southampton Univ. (England). Inst. of Sound and Vibration Research.

INSTABILITY IN THE INTEGRATION OF ORDINARY DIFFERENTIAL EQUATIONS

P. A. Samet *In its* Numerical Methods for Vibration Probl. Vol. 2: Stability Probl.–Non.-Linear and Transient Vibrations 2 Jul. 1966 p 1–7 refs (See N68-17507 08-32)

Instability is considered in relation to the numerical integration of initial value problems involving systems of ordinary differential equations. A step-size for the integration is selected so that most of the solutions have a modulus less than one, with the step-size limited by the need to have a polynomial as a good approximation to the solution, at least over a small interval. Runge-Kutta and multi-step methods are considered. M.W.R.

N68-17532*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ON THE POINCARE–VON ZEIPEL AND BROWN–SHOOK METHODS OF THE ELIMINATION OF THE SHORT PERIOD TERMS FROM A HAMILTONIAN

P. Musen Washington Mar. 1968 36 p refs

(NASA-TN-D-4399) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A comparison is drawn between the methods of Poincare–von Zeipel and Brown–Shook for the elimination of the short period terms from a Hamiltonian by means of canonical transformations. The general theory is developed, and a table of operators is supplied which serve both to eliminate short period effects of any order and to invert the canonical transformation, i.e., to express the original elements in terms of the elements affected only by the long period perturbations. The generating functions which produce these operators are the Taylor and the Lagrange operators. The Lagrange operator is a generalization of the classical operator to the case of several independent variables. In every attempt to solve the problem of the general perturbations using the electronic machines, the table of differential operators and the recurrence relations between them constitute an essential part of the programming. The elimination of the short period terms seems to be somewhat simpler in the Brown–Shook method than in Poincare–von Zeipel method. Author

N68-17571 Institute of Mathematical Science, Madras (India).

REPRESENTATION THEORY FOR BANACH ALGEBRAS AND LOCALLY COMPACT GROUPS

J. H. Williamson (Cambridge Univ.) Jan. 1967 96 p refs

(MatScience-54) CFSTI: $3.00

An introduction is presented to some of the basic theorems of representation theory. Theorems and examples are given on algebras with involution, positive functionals, indecomposable functionals and irreducible representations, the self-adjoint elements of B as a Banach space, the elements $x^* x$ as a cone in B_s, the realization of B^*-algebras as C^*-algebras, representations of locally compact groups, and representations of compact groups. M.G.J.

N68-17572 Institute of Mathematical Science, Madras (India).

DUALITY THEORY IN LOCALLY CONVEX SPACES

V. Krishnamurthy (Birla Inst. of Technol. and Sci.) [1967] 41 p refs

(MatScience-53) CFSTI: $3.00

Basic information is presented on linear spaces, and examples are given of a seminormed linear space which is not normed, weak topologies, dual systems, locally convex (1c) spaces, and 1c spaces in duality. Theorems on duality theory are stated, and topologies on linear space are mathematically defined. Data are tabulated on various topologies on 1c spaces and their dual. Consideration is also given to the question of determining when a 1c space is the strong dual of another 1c space, with interest centered on differentiating between a Banach space and a conjugate Banach space. M.G.J.

N68-17668 Institute for Mathematical Sciences, Madras (India).

TRANSFINITE DIAMETER AND ITS APPLICATIONS

W. K. Hayman [1967] 65 p refs

(Rept.-45) CFSTI: $3.00

In the lecture series presented, basic theorems and principles are presented on upper semicontinuity, Green's function and the transfinite diameter, applications to conformal mapping, transfinite diameter and capacity, and sets of capacity zero and meromorphic functions. M.G.J.

N68-17670# Aktiebolaget Atomenergi, Stockholm (Sweden).

SOLUTION OF LARGE SYSTEMS OF LINEAR EQUATIONS WITH QUADRATIC OR NON-QUADRATIC MATRICES AND DECONVOLUTION OF SPECTRA

K. Nygaard Dec. 1967 16 p refs

(AE-307) CFSTI: $3.00/MF $0.65

The numerical deconvolution of spectra is equaivalent to the solution of a (large) system of linear equations with a matrix which is not necessarily a square matrix. The demand that the square sum of the residual errors shall be minimum is not in general sufficient to ensure a unique or "sound" solution. Therefore other demands which may include the demand for minimum square errors are introduced which lead to "sound" and "non-oscillatory" solutions irrespective of the shape of the original matrix and of the determinant of the matrix of the normal equations. Author

N68-17770# Research Analysis Corp., McLean, Va.

A BRANCH-AND-BOUND ALGORITHM FOR MULTILEVEL FIXED-COST PROBLEMS

Arnold P. Jones and Richard M. Soland Oct. 1967 24 p refs

(Contract DA-44-188-ARO-1)

(RAC-TP-285; AD-663825)

Multilevel fixed-cost problems are mathematical optimization problems in which the separable portion of the objective function is the sum of piecewise continuous functions of a single variable. This paper describes a branch-and-bound algorithm that will find a global solution to this type of problem. The algorithm has the feature that a good feasible solution is generated at the start. Moreover, at each step of the algorithm an additional feasible solution may be generated for comparison with the best solution found previously. Author (TAB)

N68-17786# Institute for Advanced Studies, Dublin (Ireland).

ASPECTS OF THE CURRENT ALGEBRA APPROACH

C. Ryan 1967 68 p refs Presented at a Seminar given at Univ. of Glasgow, Edinburgh and Durham, May 1966 Its Ser. A, No. 17 Available from Dublin Inst. for Advanced Studies: 10s

A fairly simple account of and commentary on the early development of the current algebra approach is reported along with an outline of what is meant by this approach and how it is used to obtain results of physical interest. The major ingredients of the approach are discussed in relation to physical operators that satisfy a commutation relation and current commutation relations in general. The Lee–Dashen–Gell–Mann procedure is employed to find solutions on the infinite set of equations represented by an equal time current commutation relation, and the difficulties associated with this procedure are assessed. The Fubini–Furlan technique is another approach described for deriving physical results, in which physical quantities are expressed in terms of integrals over cross-sections or known matrix elements. The Fubini–Furlan technique is further evaluated for its usefulness in problems of renormalization

of strangeness changing axial current, pion–pion and pion–kaon scattering, and baryon magnetic moments. The development of a method of deducing the consequences of current commutation relations in a formally covariant way is also presented. B.S.D.

N68-17866# Stanford Univ., Calif. Dept. of Statistics.
MODELS FOR COMPETITIVE BIDDING UNDER UNCERTAINTY
Armando Ortega Reichert 2 Jan. 1968 279 p refs
(Contracts Nonr-225(53); Nonr-225(89))
(TR-103; TR-8; AD-663909)

The study analyzes competitive bidding processes as strategy decision problems under uncertainty. In bidding, a decision-maker may have uncertainty about several factors: the reliability of his information, the payoff he will accrue if his bid is successful, his competitors decision process, and their reaction to the outcome of a bidding process. Quantitative models are developed to incorporate the interrelationship of these factors in the form of competitive games. TAB

N68-17904# RAND Corp., Santa Monica, Calif.
VERIFICATION OF THE INVARIANT IMBEDDING METHOD FOR CERTAIN FREDHOLM INTEGRAL EQUATIONS
H. H. Kagiwada and R. E. Kalaba Jan. 1968 24 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5556-PR; AD-663725)

Previous RAND studies have shown that the solution of the Fredholm integral equation satisfies an initial-value problem. In the present study, the converse is shown to be true: the solution of the initial-value problem is a solution of the integral equation. It is assumed that the kernel is exponential in form. First, the integral equation is rewritten to show the dependence on the upper limit of integration. Next, an initial-value problem for the solution of the integral equation is derived in which the internal point remains fixed while the interval length is varied. During this procedure, the solution to the auxiliary integral equation and the solution of the Sobolov integral equation are introduced. Then, the validity of the Cauchy problem is established. Author (TAB)

N68-17945# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
ON A BRANCH-AND-BOUND METHOD FOR SEPARABLE CONCAVE PROGRAMS
D. W. Walkup Sep. 1967 21 p refs *Its* Mathematical Note No. 527
(D1-82-0670; AD-663680)

A separable concave program is defined to be any program of the form: Minimize z(x) subject to x in K, where K is any subset of n-space and z(x) is a separable concave function, i.e. can be written as a sum of n concave functions each of which depends on only one of the components of the vector x. (A familiar special case is the so-called fixed charge linear program.) It is shown how a branch-and-bound algorithm for a separable concave program can always be obtained if the related program of minimizing a linear function over K can be performed efficiently. A special case is considered in which K is a very large discrete set but can be described as the vector sum of smaller sets. The branch-and-bound algorithm for this special case has been programmed and applied to a problem of selecting a minimum cost fleet of space vehicles. Author (TAB)

N68-18011# RAND Corp., Santa Monica, Calif.
AN OPTIMALITY CONDITION FOR DISCRETE DYNAMIC PROGRAMMING WITH NO DISCOUNTING
E. V. Denardo and B. L. Miller Dec. 1967 30 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5534-PR; AD-663406)

The report presents a discussion of undiscounted problems having infinite planning horizons. The study develops an optimality condition for the discrete time, finite stage Markov decision problem with Veinotts criterion of maximizing the Cesaro mean of the vector returns in a finite horizon as the horizon tends to infinity. Veinotts conjecture that there are optimal stationary policies is also verified. TAB

N68-18028# Royal Aircraft Establishment, Farnborough (England).
AUTOMATIC PLOTTING OF NYQUIST DIAGRAMS
J. M. Freeland and B. E. Taylor Sep. 1967 18 p ref
(RAE-TR-67246; AD-663874)

The report explains how to use Mercury autocode programme 319 to plot Nyquist diagrams on the Benson-Lehner incremental plotter. Author (TAB)

N68-18043# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
SIMULTANEOUS TESTS FOR MULTIPLE COMPARISONS OF GROWTH CURVES Final Scientific Report
P. R. Krishnaiah Sep. 1967 19 p refs
(ARL-67-0199; AD-663714)

The paper gives simultaneous test procedures for multiple comparisons of polynomial coefficients of several polynomial growth curves when errors are autocorrelated. Simultaneous tests are also proposed for multiple comparisons of polynomial growth curves in a multivariate case. These test procedures are based upon the conditional distributions of certain observations holding other observations fixed. TAB

N68-18045# California Univ., Berkeley. Lawrence Radiation Lab.
NUMERICAL SOLUTION OF COUPLED, ORDINARY DIFFERENTIAL EQUATIONS
John Newman Aug. 1967 41 p refs
(Contract W-7405-ENG-48)
(UCRL-17739) CFSTI: HC$3.00/MF$0.65

A wide variety of problems involving ordinary differential equations can be linearized about a trial solution and then put into finite difference form. The resulting coupled, tridiagonal matrices can be solved readily on a high speed, digital computer, and the nonlinear problem can then be solved by iteration. Author (NSA)

N68-18053*# Research Analysis Corp., McLean, Va.
HISTORICAL SURVEY OF SEQUENTIAL UNCONSTRAINED METHODS FOR SOLVING CONSTRAINED MINIMIZATION PROBLEMS
Anthony V. Fiacco Jul. 1967 23 p refs
(Contract DA 44-188-ARO-1)
(RAC-TP-267; AD-663824)

The paper gives a chronological account of significant developments in the evolution of unconstrained methods for solving mathematical programming (constrained extremization) problems. The particular methods of interest are based on the unconstrained minimization of a parametric auxiliary function for a specified sequence of values of the parameters. Under suitable conditions the minimizing sequence yields limit points that solve the original constrained problem. The general defining properties of such methods are sketched first. The common basic form of the auxiliary functions conventionally utilized is described and provides a formal synthesis of the so-called interior and exterior point penalty function techniques. It is indicated in what sense the associated Lagrange multiplier technique and the conditions for optimality of the programming problem are closely associated with the considered approach. Certain key results are then briefly summarized and assessed--in the order of their appearance in the literature--in sufficient detail to indicate the degree of development and level of generality of methods based on particular auxiliary functions. A further synthesis of the sequential unconstrained penalty methods with the methods of centers is noted. The paper concludes with a brief summary of generalizations and extensions that have been obtained very recently. To recapitulate, in addition to giving a factual account of the progress made in this area, the paper

endeavors to provide a perspective for certain significant developments in the approach, i.e., a basis for a synthesis of the principal techniques, and an appraisal of specific results. Author (TAB)

N68-18075# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.

MAXIMUM LIKELIHOOD ESTIMATION OF A U-SHAPED FAILURE RATE FUNCTION

T. A. Bray, Gordon B. Crawford, and Frank Proschan Oct. 1967 44 p refs *Its* Mathematical Note No. 534

(D1-82-0660; AD-663678)

A maximum likelihood estimate (MLE) is derived for the failure rate as a function of age based on incomplete data, assuming the failure rate function is initially decreasing and subsequently increasing, with the turning point unknown. An algorithm for computation of the MLE is developed; a small worked example is included to show in detail the steps of the algorithm. A program for machine computation is presented. The MLE is shown to be a consistent estimator. No further assumption is required as to the mathematical form of the life-length distribution (such as exponential, Wiebull, normal, etc.). Thus the model may be realistically applied in a variety of reliability situations, where the so-called bathtub shaped failure rate is appropriate. In the present paper it is applied to the analysis of airplane part failure data. A real life large-scale example is presented in which the failure rate of a constant speed drive unit of a jet airplane is estimated. Author (TAB)

N68-18127# Technische Hogeschool, Eindhoven (Netherlands)

DECISION RULES IN MARKOVIAN DECISION PROCESSES WITH INCOMPLETELY KNOWN TRANSITION PROBABILITIES

Jacobus Wessels (Ph.D. Thesis) 1968 163 p refs

CFSTI: HC $3.00/MF $0.65

The formulation of a mathematical model describing decision processes based on time independent Markov chains with incomplete transition probabilities is presented with a decription of a Markovian decision process. Two decision rules discussed include those which allow mixing at any moment of decision, and mixed decision rules applying to mixed strategies. These decision rules base their actual decisions at any time on the complete state history realized so far. Consideration is also given to the partial ordering of the decision rules induced by the risk functions, and whether sets of admissible decision rules are complete. Partial decision and mixed decision rules are presented along with optimum decision rules which are the min–max risk and min–max regret. The Bayesian approach to develop decision rules is also evaluated. B.S.D.

N68-18167# Massachusetts Inst. of Tech., Cambridge. Operations Research Center.

QUASI-SEPARABLE UTILITY FUNCTIONS

Ralph Lyons Keeney (M.S. Thesis) Dec. 1967 126 p refs

(Contract DA-31-124-ARO(D)-209; Nonr-3963(06))

(TR-33; AD-663829)

The research is concerned with assessment of utility functions for multi-numeraire consequences. More specifically, it is proven that given von Neumann and Morgansterns axioms of rational behavior and two additional assumptions, the utility function for (x sub i, y sub i) consequences must be of the form U sub xy(x sub i, y sub i) = U sub x(x sub i) + U sub y(y sub i) + K U sub x(x sub i) U sub y(y sub i). K is a constant that must be empirically evaluated. It is shown that this form, known as a quasi-separable utility function, is more general than the separable utility function and nearly as easy to use. The implications and ramifications of such a utility function and its requisite assumptions are discussed in detail. Expressions for evaluating the expected utility of a probabilistic consequence are derived. The problems and technique of practical application of the theory are considered. A discussion of the usefulness of this work and of possible future research topics concludes the report. Author (TAB)

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N68-17343 Freie Univ., Berlin (West Germany).

METEOROLOGICAL DATA. VOLUME 28, NO. 9: RESULTS OF THE SYNOPTIC SERVICE, SEPTEMBER 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND 28, HEFT 9: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967]

Richard Scherhag 1968 175 p refs In GERMAN

Articles on the following subjects are presented: (1) weather forecasting for September 1967; (2) the balance drift of the ice station Alpha; and (3) mass and heat budget of the arctic sea ice. For Berlin, Germany, summaries are given of climatological means, temperatures, precipitation, and radioactivity, all for September 1967. Daily weather charts are presented for Germany, Europe, and the northern hemisphere, and two additional articles summarize the climatology and the world weather situation during September 1967. Transl. by K.W.

N68-17344 Freie Univ., Berlin (West Germany).

METEOROLOGICAL DATA. VOLUME 79, NO. 10: DAILY AND AVERAGE SURFACE AND 850 MB MAPS OF THE NORTHERN HEMISPHERE, OCTOBER 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND 79, HEFT 10: TAEGLICHE UND MITTLERE BODEN- UND 850-MB-KARTEN DER NORDHEMISPHAERE IM JAHRE 1967, OKTOBER]

Manfred Geb and Richard Scherhag 1968 84 p In GERMAN

A summary of the world weather situation during October 1967 is given in addition to charts showing average atmospheric conditions and precipitation, daily 850-mb charts, and daily ground charts for the same month. All charts are of the northern hemisphere. Transl. by K.W.

N68-17345 Freie Univ., Berlin (West Germany).

METEOROLOGICAL DATA. VOLUME 28, NO. 10: RESULTS OF THE SYNOPTIC SERVICE, OCTOBER 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND 28, HEFT 10: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967]

Richard Scherhag 1968 194 p refs In GERMAN

Articles are presented on: (1) weather forecasting for October 1967; (2) hurricane names of the 1967 season; (3) new methods for measuring duration of sunshine; (4) study of tornado activity in Oklahoma, U.S.A.; (5) radioactivity in the stratosphere following the first Chinese H bomb test, June 17, 1967; and (6) diurnal variations of precipitation. For Berlin, Germany, summaries are given of climatological means, temperatures, precipitation, and radioactivity, all for October 1967. Daily weather charts for October 1967 are presented for Germany, Europe, and the northern hemisphere, and two additional articles summarized the climatology and the world weather situation during October 1967. Transl. by K.W.

N68-17346 Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.

METEOROLOGICAL DATA. VOLUME 85, NO. 4: RESULTS OF THE OZONE ASCENTS OF THE BERLIN TEMPELHOF RADIOSONDE STATION OF THE METEOROLOGY AND GEOPHYSICS INSTITUTE OF THE BERLIN FREE UNIVERSITY, NOVEMBER 1966–JUNE 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND 85, HEFT 4: ERGEBNISSE DER OZON AUFSTIEGE DER RADIOSONDENSTATION BERLIN-TEMPELHOF DES INSTITUT FUER METEOROLOGIE UND GEOPHYSIK DER FREIEN UNIVERSITAET BERLIN, NOVEMBER 1966–JUNI 1967]

Edgar Maedlow and Eugen Pantzke 1967 174 p refs In GERMAN; ENGLISH summary

After brief descriptions of the electrochemical sounding method, the process of evaluation, and the Berlin sounding equipment, the results of 71 flights during the period November 1966 through June 1967 are presented. Monthly and seasonal means and profiles are also given. The reliability of the measurements is discussed. Author

N68-17476# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
A STATISTICAL MODEL OF ATMOSPHERIC TURBULENCE AND A REVIEW OF THE ASSUMPTIONS NECESSARY FOR ITS USE
Francis E. Pritchard *In* AGARD Stability and Control, Pt. 2 Sep. 1966 p 907-936 refs (See N68-17460 08-02)

An updated and extended statistical model of atmospheric turbulence is presented. The nature of the power spectral densities of atmospheric turbulence are described. The common assumptions used to simplify the presentation and application of atmospheric turbulence models, which include stationarity, homogeneity, isotropy, Taylor's hypothesis, and normality of velocity fluctuations, are reviewed and assessed. The mathematical techniques required for turbulence models are briefly described. A low altitude spectral model is presented for the three turbulence velocity components. The intensity and scale of the vertical gust velocity component are modeled as functions of meteorological parameters and related to the scales and intensities of the other components. The probability density and cumulative probability of the r.m.s. vertical gust velocity are also given. For higher altitudes where spectral data is nearly nonexistent, an exceedance model of turbulence is given. The model consists of parameters defining the probability of encountering turbulence of a given type and the intensity of the given type of turbulence. R.N.A.

N68-17491# Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME 75, NO. 1: METEOROLOGICAL INVESTIGATION OF MARKED CONCENTRATIONS VARIATIONS OF NATURAL RADIOACTIVITY IN THE AIR [METEOROLOGISCHE ABHANDLUNGEN. BAND 75, HEFT 1: METEOROLOGISCHE UNTERSUCHUNG MARKANTER KONZENTRATIONS-AENDERUNGEN DER NATUERLICHEN RADIOAKTIVITAET DER LUFT]
Gernot Gross 1967 70 p refs In GERMAN; ENGLISH summary

Radon and thoron are the essential original elements of natural radioactivity in atmosphere and therefore a good aid in measuring and examining meteorological actions of the atmospheric ground-layer. The effect of various meteorological facts on radon concentration of the ground level atmosphere is examined in detail. The marked mean diurnal and annual variations of specific radioactivity in atmosphere are reflecting the vertical transport of masses influenced by radiation. There is a distinct relation of radon concentration to wind direction and wind velocity. The differences between measurements and model values give hint, among others, to important radon source regions in the German sub-alpine mountains. The results of this discussion show that essential changes of radon concentration of the ground level atmosphere are caused only by vertical transport of masses and by advective actions. Their interaction is shown in selected examples of marked variations of concentration. Author

N68-17528# Joint Publications Research Service, Washington, D. C.
METEOROLOGY
In its Soviet Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 173 2 Feb. 1968 p 11-16 refs (See N68-17526 08-13)

Brief descriptions are presented on meteorological research, emphasizing the determination of the height and wind speed of jet streams. Ocean and atmospheric interaction, solar activity and storm relation, and cloud cover data are described. Outgoing radiation measurements, hail prevention methods, and the development of a new anemometer are mentioned. N.E.N.

N68-17550# Royal Aircraft Establishment, Farnborough (England).
THE ECONOMIC EFFECTS OF METEOROLOGICAL FORECASTING STANDARDS FOR SUPERSONIC CIVIL TRANSPORTS
A. L. Courtney Sep. 1966 25 p refs
(RAE-TR-66297)

An approximate assessment is made of the effects of changes in the accuracy with which en-route and take-off winds and temperatures can be forecast. The results are given in terms of the annual value calculated over the world total of long-range civil operations, first for a current subsonic fleet equivalent to about 350 Boeing 707's and then for a possible supersonic fleet equivalent to about 400 Concordes, such as might be in operation in 1980-1985. It is found that in current long-range subsonic operations the accurate forecasting of en-route winds is the most important item. In future supersonic operations, however, the most important item is likely to be the accurate forecasting of en-route temperature, wind being of comparatively minor importance. Accuracy in forecasting the airfield temperature for take-off is also likely to be important. Author

N68-17551*# Control Data Corp., Minneapolis, Minn. Research Div.
STRATOSPHERIC CIRCULATION STUDIES BASED ON TIROS 7, 15-MICRON DATA Final Report
A. D. Belmont, W. C. Shen, and G. W. Nicholas 2 Jun. 1967 81 p refs
(Contract NAS5-10171)
(NASA-CR-92554) CFSTI: HC $3.00/MF $0.65 CSCL 04B

CONTENTS:

1. COMPARISON OF TIROS 7, 15-MICRON DATA WITH RADIOSONDE TEMPERATURES FINAL REPORT A. D. Belmont, G. W. Nicholas, and W. C. Shen 35 p refs (See N68-17552 08-20)

2. ANTARCTIC STRATOSPHERIC WARMINGS DURING 1963 REVEALED BY TIROS 7, 15-MICRON DATA FINAL REPORT W. C. Shen, G. W. Nicholas, and A. D. Belmont 43 p refs (See N68-17553 08-20)

N68-17552*# Control Data Corp., Minneapolis, Minn. Research Div.
COMPARISON OF TIROS 7, 15-MICRON DATA WITH RADIOSONDE TEMPERATURES Final Report
A. D. Belmont, G. W. Nicholas, and W. C. Shen *In its* Stratospheric Circulation Studies Based on TIROS 7 15-Micron Data 2 Jun. 1967 35 p refs Its Paper No. 1 (See N68-17551 08-20)
(Contract NAS5-10171)

Temperatures derived from the 15-micron carbon dioxide channel of the radiometer carried aboard the TIROS VII satellite were compared to the radiosonde temperatures at 100, 70, 50, 30, 20 and 10 mb at 97 stations in the northern hemisphere from 20 January to 17 February 1964. The 15-micron temperature is rarely colder than the 30-mb temperature, and it generally falls between the 10- and 30-mb temperature. The highest correlation between 15-micron and radiosonde temperatures was 0.7 at both 30 mb and 20 mb, near the level of maximum weight which applies to the 15-micron radiance weighting function profile. Author

N68-17553*# Control Data Corp., Minneapolis, Minn. Research Div.
ANTARCTIC STRATOSPHERIC WARMINGS DURING 1963 REVEALED BY TIROS 7, 15-MICRON DATA Final Report

W. C. Shen, G. W. Nicholas, and A. D. Belmont *In its* Stratospheric Circulation Studies Based on TIROS 7 15-Micron Data 2 Jun. 1967 43 p refs Its Paper No. 2 (See N68-17551 08-20)
(Contract NAS5-10171)

Tiros 7 15-micron radiation data were used to study southern hemisphere stratospheric warmings during the winter of 1963. Three significant warmings could be mapped despite the latitudinal limit of 60S. The first, from 20 July to 13 August, and the second from 26 August to 16 September each reached a maximum in the Australian sector. The third, or final warming, occurred in the Western South Pacific Ocean. It is suggested that future observations of the same, carbon dioxide band be carefully processed to filter out only the random time fluctuations in order that this system's potentially high resolution in time and space can be realized. This waveband can provide mid-stratospheric temperature data over the major portion of the globe which now has no upper-air observational network. Only a polar orbit would further provide such data over the central polar regions where this atmospheric layer experiences dramatic changes and is of most interest. Author

N68-17599 Joint Publications Research Service, Washington, D. C.
METEOROLOGY
In its Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb 1968 p 21-32 (See N68-17597 08-13)

Research activities in weather forecasting, synoptic meteorology, and related topics are summarized. The studies described include the following: snow and hail characteristics, ball lightning, and atmospheric electricity during thunderstorms; ice formation in inland waters; cloud seeding and formation; and heat balance and circulation in the atmosphere. N.E.N.

N68-17686 Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME 76, NO. 9: RESULTS OF THE BERLIN TEMPELHOF RADIOSONDE STATION ASCENTS OF THE METEOROLOGY AND GEOPHYSICS INSTITUTE OF THE BERLIN FREE UNIVERSITY, SEPTEMBER, 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND 76, HEFT 9: ERGEBNISSE DER AUFSTIEGE DER RADIOSONDENSTATION BERLIN-TEMPELHOF DES INSTITUTS FUER METEOROLOGIE UND GEOPHYSIK DER FREIEN UNIVERSITAET BERLIN IM JAHRE 1967, SEPTEMBER]
Richard Scherhag et al 1968 96 p refs In GERMAN; ENGLISH summary

The detailed results of the radiosonde ascents performed by the aerological station of Berlin are presented. Extreme and mean values of the temperature, geopotential, pressure, wind data, refractivity, density, pseudopotential temperature and velocity of sound for all standard pressure surfaces and for several height levels, the tropopause and the freezing level were extracted. Author

N68-17695 Freie Univ., Berlin (West Germany).
METEOROLOGICAL DATA. VOLUME 79, NO. 9: DAILY AND AVERAGE SURFACE AND 850 MB MAPS OF THE NORTHERN HEMISPHERE, SEPTEMBER 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND 79, HEFT 9: TAEGLICHE UND MITTLERE BODEN- UND 850-MB-KARTEN DER NORDHEMISPHAERE IM JAHRE 1967, SEPTEMBER]
Manfred Geb and Richard Scherhag 1968 82 p In GERMAN

This document contains the daily, and median ground and 850 mb aerological charts of the Northern Hemisphere for September, 1967. The almost persistent pressure anomalies near the equator enlarged during this period and pushed the low pressure ring of the northern tropics and subtropics towards the North. Air humidity and precipitation increases concentrated in the sea area south of Japan and numerous hurricanes developed during the middle of the month. Transl. by G.G.

N68-17696 Freie Univ., Berlin (West Germany).
METEOROLOGICAL DATA. VOLUME 65, NO. 4: DAILY ALTITUDE MAPS OF THE 100 MB LAYERS ACCORDING TO MONTHLY MEAN MAPS [METEOROLOGISCHE ABHANDLUNGEN. BAND 65, HEFT 4: TAEGLICHE HOEHENKARTEN DER 100-MB-FLAECHE SOWIE MONATLICHE MITTELKARTEN FUER DAS JAHR 1966. TEIL 4,4. VIERTELJAHR] Quarterly Report, 1966
Richard Scherhag, and Renate Stuhrmann 1967 119 p In GERMAN
(QR-4)

Daily, and median monthly aerological maps are presented for the 100 millibarn level of the atmosphere over the Northern Hemisphere. Measurements cover the year 1966. Also included is a stratospheric circulation analysis for the last quarter of 1966; it established a pronounced cooling trend and the typical development of winter temperature patterns. Transl. by G.G.

N68-17697 Freie Univ., Berlin (West Germany).
METEOROLOGICAL DATA. VOLUME 80, NO. 1: DAILY ALTITUDE MAPS OF THE 100 MB LAYERS AND 50 MB LAYERS ACCORDING TO MONTHLY MEAN MAPS [METEOROLOGISCHE ABHANDLUNGEN. BAND 80, HEFT 1: TAEGLICHE HOEHENKARTEN DER 100-MB-FLAECHE UND DER 50-MB-FLAECHE SOWIE MONATLICHE MITTELKARTEN FUER DAS JAHRE 1967. TEIL 1, VIERTELJAHR] Quarterly Report, 1967
Wolfgang Roeder, Richard Scherhag et al 1968 230 p In GERMAN

Daily and median monthly aerological maps are presented for the 100 mb, and the 50 mb levels of the Northern Hemisphere. Measurements cover the first quarter of the year 1967. Transl. by G.G.

N68-17766# Air Force Cambridge Research Labs., Bedford, Mass. Aerospace Instrumentation Lab.
A STUDY OF MESOSCALE FEATURES OF SUMMERTIME MINIMUM WIND FIELDS IN THE LOWER STRATOSPHERE
George F. Nolan Nov. 1967 20 p refs *Its* Environmental Res. Papers, no. 275
(AFCRL-67-0601; AD-663444)

Mesoscale observations of summertime minimum wind fields in the lower stratosphere disclose a complex mesostructure in the winds located between the stratospheric easterlies and tropospheric westerlies. Anticyclonic rotation of wind directions appears to predominate but speeds, although low, are highly variable. There are a number of layers, averaging 1000 ft thick, that have a speed of less than 10 kt. These layers seem to have no traceable continuity in time or space. There is evidence of significant inertial influence on winds of less than 10 kt. Two sets of data were obtained from radiosondes with extended power supplies carried on large plastic balloons that made slow ascents and descents through this region of the atmosphere. The success of these ventures supports the concept of using free-floating and tethered balloons as hovering or station-keeping vehicles. Author (TAB)

N68-17940# Naval Postgraduate School, Monterey, Calif. Dept. of Meteorology and Oceanography.
A NUMERICAL SCHEME FOR THE PREDICTION OF HURRICANE AND TYPHOON MOVEMENT Progress Report
Robert J. Renard Dec. 1967 57 p refs Presented at the IUGG-AMS 5th Tech. Conf. on Hurricanes and Tropical Meteorol., Caracus, 20-28 Nov. 1967 Submitted for publication
(PR-1; AD-663459)

The vector motion of severe tropical cyclones (including storm, hurricane/typhoon stages) is forecasted by a numerical scheme which involves two steps: (a) Numerical geostrophic steering of the center of the cyclone using the U. S. Navy Fleet Numerical Weather Facilitys (FNWF) operationally-produced smoothed isobaric

height fields, called SR. (b) The numerical-steering prediction is objectively modified to adjust for bias (i.e., deficiency in both zonal and meridonal motion) by utilizing errors made in the most recent 12- and 24-hour numerical-steering forecasts. Stratification of error statistics by area, trajectory and stage of storm, intercomparison with ESSAs NHC-64 technique, discussion of merits and deficiencies of the research program relative to operational forecasts and current experiments at FNWF, are discussed. TAB

N68-18026# Freie Univ., Berlin (West Germany). Institut fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME 74, NO. 2: THUNDERSTORMS AND THEIR THEORIES [METEOROLOGISCHE ABHANDLUNGEN. BAND 74, HEFT 2: DAS GEWITTER UND SEINE THEORIEN]
Hartmut Boehrenz 1967 86 p refs In GERMAN; ENGLISH summary

This essay treats the cloudphysical border conditions for the build-up of the electric field which causes lightning. Although the thunderstorm circulations discussed in all their effects are well understood because of the clear results of surveyal, the questions concerning the electrical occurrences still remain to be solved. On the basis of research by R. Scherhag and statistics of world thunderstorms published by the World Meteorological Organization, the thunderstorm has been assigned its place in the worldwide pattern of meteorological activity. Author

N68-18030 Freie Univ., Berlin (West Germany).
METEOROLOGICAL DATA. VOLUME 28, NO. 8: RESULTS OF THE SYNOPTIC SERVICE, AUGUST 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND 28, HEFT 8: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967]
Richard Scherhang 1968 90 p refs In GERMAN

Presented synoptic meteorological weather charts for August, 1967, consist of daily weather data for ground, 500 mb, and 200 mb altitude. Observed was the atmosphere over the Northern Hemisphere with emphasis on the climatic environment of Berlin. Also included are brief reports on precipitation amounts for Berlin, radioactive fallout over the southern United States, and the description of measurement registration system for the meteorological and geophysical institute of the city of Berlin. G.G.

N68-18109*# Avco Corp., Lowell, Mass. Space Systems Div.
TEMPERATURE SOUNDING WITH THE 4.3 MICRON CO_2 BAND
Robert A. Mc Clatchey *In* NASA Mol. Radiation and Its Appl. to Diagnostic Tech. 8 1968 p 439–442 ref (See N68-18082 08-33)

An overview is presented on an experiment which is being developed to determine the vertical temperature structure and other meteorological parameters by making measurements in the vicinity of the 4.3μ CO_2 band. A grating spectrometer having 35 individual channels is also being developed for this purpose. The spectral location of this band with respect to the solar radiation curve is depicted, along with a representation of the energy/cm^2/sec/steradian/wave number that would be received by a satellite-borne instrument. A mean earth albedo of 0.40 and a surface brightness temperature of 275°K are assumed. Plans also call for measurements at longer wavelengths up to and including the short wavelength wing of the 6.3μ H_2O band; and determination of the temperature structure of the atmosphere in six atmospheric layers. M.G.J.

N68-18110*# GCA Technology Div., GCA Corp., Bedford, Mass.
NUMERICAL STUDY OF NONLINEAR INVERSION
Edwin T. Florance *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 443–448 refs (See N68-18082 08-33)
(Contract NAS5-10393)

Preliminary results are presented on a numerical study of nonlinear inversion applied to the inference of atmospheric temperature profiles from satellite radiometric measurements in the 15 micron absorption band of CO_2. A generalized nonlinear inversion method, applicable to a wide class of band absorption spectra, is developed. Author

N68-18194# International Geophysical Year World Data Center A, Washington, D. C.
METEOROLOGICAL ROCKET NETWORK FIRINGS Data Report
May 1967 263 p *Its* Vol. 4, No. 5
CFSTI: HC $3.00/MF $0.65

Wind and temperature data are tabulated from Meteorological Rocket Network station reports of May 1967 firings. These tables also contain computed values for pressure, density, and speed of sound, and local radiosonde observations nearest the time of firing. The data reduction procedures used in correlating reports from the individual stations are described. E.J.S.

N68-18246*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WIND DATA FROM THE 250-FOOT (76.2-METER) TOWER AT WALLOPS ISLAND, VIRGINIA
James A. Cochrane and Robert M. Henry Washington Mar. 1968 46 p refs
(NASA-TN-D-4395) CFSTI: HC $3.00/MF $0.65 CSCL 04B

A nearly continuous 3-1/2 year sample of low-level wind data has been collected from anemometers mounted at five levels on the 250-foot meteorological tower at Wallops Island, Virginia. Fifteen-minute averages of speed and direction were read out at hourly intervals. The statistical treatment and the homogeneity of the sample are discussed. Two types of statistical information—frequency-distribution data and statistical parameters—were computed from the sample. The frequency-distribution information is of three types: (1) percentage probabilities of being less than or equal to a given value of wind speed; (2) wind-speed limits for selected percentiles; and (3) frequency of speed-direction groups. The tabulation of fundamental statistical parameters provides further information on specific properties of the wind distribution. The parameters are presented for various combinations of hourly, monthly, and annual periods. The statistical data included in this report provide the best available information on the low-level wind environment and should be useful for establishing design criteria and supporting launch operations. Author

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N68-17381*# Chrysler Corp., New Orleans, La. Space Div.
AS-206A PRELIMINARY L/V OPERATIONAL TRAJECTORY AND GUIDANCE PRESETTINGS
G. W. Klug and T. B. Pederson 7 Nov. 1966 60 p refs
(NASA-CR-93293; TN-AP-66-125) CFSTI: HC $3.00/MF $0.65 CSCL 17G

This document presents the S-IB stage steering program and the Iterative Guidance Mode (IGM) presettings for the AS-206A Mission. In addition, the associated AS-206A preliminary launch vehicle operational trajectory and a summary of the SA-206 Launch Vehicle performance characteristics are presented for review and critique. The S-IB stage tilt program was derived to provide a near zero angle of attack history throughout the high dynamic

pressure region of flight assuming a zero wind profile. However, the AS-206A Preliminary L/V operational trajectory was generated using a mean April head/tail wind profile. The nominal SA-206 Launch Vehicle weight in orbit capability is predicted to be 6,857 pounds in excess of the propellant depletion weight. Based on an FPR of 1,330 pounds, approximately 5,527 pounds of S-IVB propellant can be allocated for an inflight alternate mission. Author

N68-17414# Royal Aircraft Establishment, Farnborough (England).
INTRODUCTION TO SPACECRAFT ATTITUDE CONTROL
W. G. Hughes *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 13–35 (See N68-11413 08-31)

After a brief mention of the need for attitude control, the four principle methods are discussed: active and passive referenced systems, and active and passive inertial systems. For active referenced systems, sensors are required to indicate the actual attitude of the satellite. The most useful attitude sensors, namely, star, sun, and earth sensors, are described. The last part of the lecture deals with the control actuators which are necessary in the active systems to bring the satellite into the desired attitude. The two types of control actuator are illustrated by reference to mass-ejection systems and reaction-wheel systems. Author (ESRO)

N68-17415# European Space Technology Center, Noordwijk (Netherlands).
OPERATION OF THE L.A.S. CONTROL SYSTEMS
D. Marsh *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 47–65 (See N68-17413 08-31)

The attitude control requirements for the ESRO Large Astronomical Satellite (L.A.S.) are used to derive space reference and telescope pointing concepts using a star sensor platform or an up-dated rate integrating gyro package as the reference system within the satellite. Author (ESRO)

N68-17416# European Space Technology Center, Noordwijk (Netherlands).
DESIGN OF ATTITUDE LOOPS FOR THE L.A.S.
B. Sunesson *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 67–90 (See N68-17413 08-31)

The control system presented for the ESRO Large Astronomical Satellite (L.A.S.) is based on continuous stellar reference. The design of the system is closely affected by the L.A.S. subsystem, and these are briefly described. The control system itself is then dealt with; an account is given of the sequence of modes of operation, illustrated by charts. Author (ESRO)

N68-17417# General Electric Co., Philadelphia, Pa. Missile and Space Div.
NIMBUS STABILIZATION AND CONTROL
Lewis T. Seaman *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 91–129 refs (See N68-17413 08-31)

After a statement of the Nimbus mission, the general design of the spacecraft is described. The next section deals with the control subsystem, which has three loops: pitch and roll control, yaw control, and solar array control. A brief description follows of the design features of the major components: the horizon sensors, sun sensors, yaw gyro, electronics, solar array drive, slip rings, flywheel, and reaction gas jets. Finally, some ground test results are given, followed by details of the performance of the stabilization and control subsystem during the two Nimbus flights to date. Author (ESRO)

N68-17418# Elliott Bros., Ltd., London (England). Space and Guided Weapons Div.
A SATELLITE ATTITUDE CONTROL SYSTEM USING PROPANE
J. L. Tracy *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 131–163 refs (See N68-17413 08-31)

The initial acquisition of this propane attitude control system is achieved by a nitrogen control unit, which also enables signals from the fine solar sensors and the rate gyros to activate the propane system in the lateral and roll channels respectively. In each channel the threshold unit containing dead zone and hysteresis is formed by two Schmitt triggers with a common thrust feedback. The signal from the Schmitt trigger is used to activate the gas control valve. Gas for the roll channel is produced by an electric boiler, and for the lateral channels by a solar boiler. Author (ESRO)

N68-17419# Elliott Bros., Ltd., London (England). Space and Guided Weapons Div.
THE CONTROL OF THE ATTITUDE OF SOUNDING ROCKETS
P. E. G. Cope *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 165–188 (See N68-17413 08-31)

It is explained why attitude control of sounding rockets is required. Methods of guidance and control are then discussed in some detail, followed by a brief mention of the intervening signal processing and the associated testing techniques. Finally, the application of the guidance and control methods is illustrated by reference to a number of actual rocket programs. Author (ESRO)

N68-17420# Centre National d'Etudes Spatiales, Bretigny-sur-Orge (France).
THE CASSIOPEIA SYSTEM [LE SYSTEME CASSIOPEE]
C. Poher *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 189–201 In FRENCH (See N68-17413 08-31)

The Cassiopeia system is described which serves to insure the attitude control of sounding rockets of the series Eridan. This system consists of inertial guidance for the coarse and of stellar sensors for the fine attitude control. Attitude corrections are achieved by compressed gas ejection through 16 nozzles; this ejection being controlled by an onboard computer. The control, whether coarse or fine, can be bi-axial or tri-axial. Its maximum useful duration is approximately 420 sec. Author (ESRO)

N68-17423# European Space Technology Center, Delft (Netherlands).
SIMULATION AND TESTING OF SPACECRAFT ATTITUDE CONTROL SYSTEMS
E. Slachmuylders *In* ESRO Control and Stabilisation of Spacecraft, Vol. 1 Jun. 1967 p 249–289 (See N68-17413 08-31)

As an introduction, the necessity is shown for testing during all phases of the development of an attitude control system; such tests comprise mathematical simulation, component tests, and subsystem and complete system dynamic tests. Emphasis is made on the latter tests, and methods and techniques are described, with an indication of the underlying philosophy and the information to be gained. The first tests to be carried out are single-degree-of-freedom tests on subunits; after a discussion of the goals of single-axis testing, three facilities are described: the knife-edge table, the air-bearing table, and the wire-suspended table. After completion of the 1-DOF tests, three-dimensional testing of the complete system is started. The difference between the two types of test is stressed, and the objectives of the 3-DOF tests are stated. Two facilities are described: the spherical air-bearing table and the servo-driven three-axis test table. Author (ESRO)

N68-17612*# National Aeronautics and Space Administration, Washington, D. C.
THE FRENCH GEODETIC SATELLITES DIADEME 1 AND 2: PRACTICAL CONTRIBUTION TO NAVIGATION BY SATELLITE [LES SATELLITES GEODESIQUES FRANCAIS DIADEME 1 ET 2: CONTRIBUTION DE L'EXPERIENCE A LA NAVIGATION PAR SATELLITES]

J. C. Husson and A. Banchereau. Jan. 1968. 30 p. refs. Transl. into ENGLISH of Centre Natl. d'Etudes Spatiales Rept.-1151-PR/PS Presented at 14th AGARD Symp. on Advan. Tech. of Navigation, Milan, 12–15 Sep. 1967
(NASA-TT-F-11451) CFSTI: HC$3.00/MF$0.65 CSCL 17G

France has launched three geodetic satellites: D1A, D1C and D1D. These satellites can be used for localization operations by Doppler effect or, in the case of D1C and D1D, by laser telemetry. The satellites do not provide world-wide coverage and transmit no orbital data, so they cannot be used as navigational satellites. They can be used for ocean-sounding operations, oceanographic, seismic, gravimetric and other survey operations. This article describes the experimental program for geodetic studies involved in these satellites and its applications to navigation. The satellites, their on-board equipment, the ground stations (in Greece, Algeria and France) and their Doppler, CNES and SAT equipment are described in detail. Author

N68-18018# Federal Aviation Administration, Washington, D. C. Dept. of Transport.
AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS) MODE 3/A IDENTITY REPLY AND EQUIVALENT MODE C ALTITUDE CODE
Kenneth Wise. Feb. 1968. 13 p. refs
(RD-68-1) CFSTI: HC$3.00/MF$0.65

The Federal Aviation Administration and the International Civil Aviation Organization (ICAO) have adopted a digital code for automatic pressure-altitude transmission via the AIR TRAFFIC CONTROL RADAR BEACON SYSTEM (ATCRBS). Salient features of the code are: (1) One-hundred foot digitizing increments; (2) range from −1000 feet to +126,750 feet; (3) unambiguous unit-distance characteristics; and, (4) altitude transmission with respect to a fixed datum of 1013.2 millibars (29.92 inches of mercury). This report is directed to aviation maintenance personnel to provide them with code tables which are needed for maintenance of airborne altitude reporting equipment. The code is tabulated for altitude increments in increasing numeric order and for the equivalent octal Mode 3/A identity reply in increasing numeric order. Author

N68-18056*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
HORIZON DEFINITION STUDY SUMMARY: HORIZON DEFINITION STUDY
Jerry C. Bates and Clarence A. Jensen. May 1967. 260 p. refs
(Contract NAS1-6010)
(NASA-CR-66432) CFSTI: HC$3.00/MF$0.65 CSCL 17G

The feasibility of a comprehensive horizon definition program is investigated in this study. The potential of the earth's infrared horizon to provide information sufficient for high-accuracy reference systems was determined and evaluated, and data requirements for the program were established. The data showed that the carbon dioxide absorption band is an extremely stable radiation source and offers the potential of providing a reference for future space guidance, navigation, control, and pointing systems accurate to approximately 0.01 degree at an altitude of 250 nautical miles. The data also revealed this reference would contain systematic variations with season and latitude but is not affected by local meteorological and geomorphological phenomena. A complete orbital experiment and mission were configured, after analysis of possible flight techniques, to allow for an evaluation of the feasibility of collecting the required data. Operation of a satellite in a 250 nautical mile and near-polar orbit was shown to be the most cost effective manner in which to collect the required experimental data. Author

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N68-17225# Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center.
SOME CHARACTERISTICS OF SECONDARY GAMMA RAY TRANSPORT IN ASYMMETRIC SNAP SHIELDS
F. R. Mynatt. [1967] 8 p. Presented at the 15th Conf. on Remote Systems Technol. and Atom Fair, Chicago, Ill.
(Contract W-7405-ENG-26)
(K-DP-2623) CFSTI: HC$3.00/MF$0.65

The discrete ordinates method for calculations of neutron and gamma transport and the tools required for its use (one- and two-dimensional transport codes, multigroup gamma cross sections, and coupling techniques) are described briefly. Two one-dimensional calculations are presented: one for a pure tungsten slab 100 cm thick, and the other for a 5-ft concrete slab with a fairly complex source at the left interface from which the most numerous source neutrons were directed almost parallel to the surface in the 5- to 6-MeV group. A two-dimensional calculation for the shield assembly for a ZrH-moderated SNAP reactor is discussed, and results are shown in figures. The shield is composed of two W zones and two LiH zones. It is concluded that the discrete ordinates method is a reasonable and effective tool for gamma transport in both extreme straightforward penetration problems and those involving unusual scattering situations. NSA

N68-17229# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik.
THE LONG-TIME BEHAVIOUR OF FAST POWER REACTORS WITH Pu-RECYCLING
A. Jansen. Oct. 1967. 22 p. refs. Presented at IAEA Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, Germany, 30 Oct.–3 Nov. 1967
(EURFNR-399; EUR-3674.E; KFK-630; CONF-671043-7) CFSTI: HC$3.00/MF$0.65

The long-time behavior of the Pu composition in the fuel and the physical aspects of the fuel cycle economy under conditions of loading and unloading the core and blanket elements is described. The loading and the unloading of the core and blanket elements are treated as discontinuous processes. The solution presented is applied to a Na-cooled 1000 MW(e) power reactor. NSA

N68-17231# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik.
REACTIVITY COEFFICIENTS OF STEAM COOLED FAST BREEDERS
E. Kiefhaber. Oct. 1967. 20 p. refs. Presented at IAEA Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, Germany, 30 Oct.–3 Nov. 1967
(EURFNR-398; EUR-3673.E; KFK-629; CONF-671043-8) CFSTI: HC$3.00/MF$0.65

Design parameters which affect the stability-behavior of steam-cooled fast breeder reactors are presented. These parameters of influence are: isotopic composition variations during burnup for Pu; cladding materials; heavy water coolant; fuel nitrides; and geometric arrangement of the core. NSA

N68-17236# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
CONTROLLED TEMPERATURE PRESSURE IRRADIATION CAPSULES

C. R. Hann, R. K. Marshall, R. D. Leggett, and J. P. Pilger 25 Oct. 1967 23 p Presented at the 15th Conf. on Remote Systems Technol. and Atom Fair, Chicago, 5–9 Nov. 1967
(Contract AT(45-1)-1830)
(BNWL-SA-1377; CONF-671102-35) CFSTI: HC $3.00/MF $0.65

Description of a temperature, pressure controlled capsule for uranium swelling studies is presented. Thermal flux profiles for several controlled temperature–pressure irradiation capsules are also presented. NSA

N68-17240# Bettis Atomic Power Lab., Pittsburgh, Pa.
INTEGRAL MEASUREMENTS OF THE EPITHERMAL NEUTRON CAPTURE-TO-FISSION CROSS-SECTION RATIOS OF ^{233}U AND ^{235}U (LWB–LSBR DEVELOPMENT PROGRAM)
D. E. Conway and S. B. Gunst Jun. 1967 48 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-613) CFSTI: HC $3.00/MF $0.65

Samples of uranium enriched in ^{233}U and in ^{235}U were irradiated with cobalt monitors in high-flux facilities in both cadmium-covered and bare assemblies. Mass-spectrometric and radio-chemical analyses of irradiation samples provide data concerning thermal and epithermal capture and fission reactions from which experimental results are obtained. The epithermal capture-to-fission cross-section ratios of ^{233}U and ^{235}U at infinite dilution are 0.175 ± 0.006 and 0.499 ± 0.016, respectively, for a 1/E spectrum with a low-energy cut-off of 0.50 eV. Resonance integrals for capture and fission are evaluated in terms of cobalt cross sections. Author (NSA)

N68-17241# Bettis Atomic Power Lab., Pittsburgh, Pa.
MECHANICAL PROPERTIES OF OXIDE FUELS (LSBR/LWB DEVELOPMENT PROGRAM)
R. A. Wolfe and S. F. Kaufman Oct. 1967 132 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-587) CFSTI: HC $3.00/MF $0.65

The mechanical properties of unirradiated oxide fuel materials have been reviewed and an evaluation has been made of the effects of temperature, stress and material variables on the elastic, plastic, creep, hot pressing, and fracture strength properties. The materials discussed include UO_2, ThO_2, ThO_2–UO_2 and ZrO_2–UO_2 compositions. Experimental data were taken from a review of the literature. Author (NSA)

N68-17242# European Nuclear Energy Agency, Paris (France). Organization for Economic Co-Operation and Development.
O.E.C.D. HIGH TEMPERATURE REACTOR PROJECT DRAGON Annual Report, 1 Apr. 1966–31 Mar. 1967
31 Mar. 1967 174 p refs
(NP-17118; AR-8)

Described is the progress of the Dragon Project for the period from April 1, 1966, to March 31, 1967. Separate sections cover research and development, operation of the reactor experiment, power reactor assessment studies and project administration. Research and development effort was concentrated on fuel element production, testing, and examination and the evaluation of reactor operating conditions. The year marked the first extended operation of the reactor at full power. First and second fuel charge irradiations were carried out, and extensive adjustments, examinations, and measurements were performed on plant components and systems. Assessment studies to establish the feasibility, safety, and costs of all the features essential to a practical high temperature gas-cooled nuclear power station were evaluated. A reference design was evolved for a 1,250 MW(t) (528 MW(e)) single reactor station using a highly enriched uranium/thorium fuel cycle, and a variant design using slightly enriched uranium fuel only is discussed. NSA

N68-17244# Atomic Energy Establishment, Winfrith (England). General Reactor Physics Div.
ON THE IMPORTANCE OF FAST SCATTERING DATA FOR ALUMINIUM IN THE INTERPRETATION OF RESULTS FROM H_2O-MODERATED LATTICE EXPERIMENTS
F. J. Fayers and M. J. Terry Jul. 1967 16 p refs
(AEEW-R-551) CFSTI: HC $3.00/MF $0.65

The importance of scattering data for Al in leakage calculations for light water systems is examined. It is shown that some discrepancy exists between calculated plane moments and experimentally measured moments, which may be corrected by an 'ad hoc' adjustment of inelastic scattering data for Al. WIMS results are presented for some Battelle Pu–Al fuelled rod lattices, and it is shown that this adjustment of inelastic data leads to a noticeable correction for the predicted reactivities of the experiments. The influence of scattering data for Al on results for some other lattices of interest is shown to be less important. Author (NSA)

N68-17245# Technische Univ., Berlin (West Germany). Institut fuer Kerntechnik.
ESTIMATION OF REACTOR KINETICS MAGNITUDES IN THE SUR 100 BE BY FIXED AND STOCHASTIC SIGNALS [BESTIMMUNG REAKTORKINETISCHER KENNGROESSEN AM SUR 100 BE MIT DETERMINIERTEN UND STOCHASTISCHEN SIGNALEN]
V. Moritz, H. Vierke, U. Wesser, L. Wolf, and W. Zeisset May 1967 346 p refs In GERMAN
(TUBIK-5)

Linear reactor kinetics describe the time behavior of a reaction-free zero power reactor such as the SUR-100-BE. It was shown that the analytical and the experimental investigations which use fixed and stochastic signals are equivalent, but the latter has some advantages in practice. Beginning with the transport theory, the kinetic reactor equations for average neutron densities were derived and their applicability for different reactor kinetic studies was indicated. With the help of an expanded signal theory, based on the information theory, fixed and stochastic signals were connected. On the basis of the characteristic of the stochastic signal the possibility of their practical introduction is given. They also lead in the analytical consideration to an expanded understanding of the processes occurring in the system. The mathematical analysis leads to a transport equation which is soluble for binary densities. This contains the complete information for the process model of the Markoff processes so that the correlation methods give more informantion than the conventional methods. Author (NSA)

N68-17246# Oak Ridge National Lab., Tenn.
EVALUATION OF THE MOLTEN SALT REACTOR EXPERIMENT HASTELLOY N SURVEILLANCE SPECIMENS: FIRST GROUP
H. E. Mc Coy, Jr. Nov. 1967 57 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1997) CFSTI: HC $3.00/MF $0.65

The first group of surveillance specimens from the Molten Salt Reactor Experiment core were removed after 7832 Mwhr of reactor operation during which the specimens were held at $645° \pm 10°C$ for 4800 hr and accumulated a thermal dose of 1.3×10^{20} neutrons/cm^2. The high-temperature ductility was reduced, but the reduction was similar to that observed for these materials when irradiated in the Oak Ridge Reactor in a helium environment. The low-temperature ductility was reduced, and this is thought to be due to the formation of intergranular M_6C. The specimens showed no evidence of corrosion; however, a carbon-rich layer, 1 to 2 mils in depth, was noted where the Hastelloy N and graphite were in contact. The mechanical properties of the Hastelloy N appear adequate for the continued satisfactory operation of the MSRE. Test results are presented for the effects of several variables

on the tensile ductility of irradiated and unirradiated Hastelloy N. These variables included test temperature, strain rate, and prestraining. Author (NSA)

N68-17263# Los Alamos Scientific Lab., N. Mex.
ADVANCED PLUTONIUM FUELS PROGRAM Quarterly Status Report, 1 Jul.–30 Sep. 1967
14 Nov. 1967 42 p refs
(Contract W-7405-ENG-36)
(LA-3820-MS; QR-5) CFSTI: HC $3.00/MF $0.65

The release and distribution of fuel and fission products in sodium systems were studied using both sealed capsules and forced-connection sodium loops. The solubility of oxygen in sodium using the vacuum-distillation analytical technique was determined over the temperature range of 125 to 300°C. Experimental facilities to be used in the development of analytical techniques for the measurement of impurities in sodium and a sodium loop to study the performance characteristics of different designs of cold traps were constructed. Several tests were conducted to determine the rates of change of oxygen concentration in the sodium loop following rapid changes in the cold-trap temperature. Studies were continued on the synthesis, fabrication, and determination of high temperature properties of plutonium and uranium carbide and oxide fuel materials. Results in the program to determine the interactions of (U,Pu)C and (U,Pu)N fuels with sodium and potential cladding materials in order to achieve a satisfactory sodium-bonded fuel element are presented. Progress is reported on the nuclear analysis and evaluation of various fast breeder concepts and proposals and on the development of evaluated cross-section data and processing codes. The development of equipment and methods to be used in the examination and comparison of neutron irradiation effects on LMFBR Program fuel materials is summarized. NSA

N68-17264# Los Alamos Scientific Lab., N. Mex.
VENTING EXPERIMENTS WITH A LIQUID PLUTONIUM ALLOY
J. C. Clifford 16 Nov. 1967 9 p refs
(Contract W-7405-ENG-36)
(LA-3766-MS) CFSTI: HC $3.00/MF $0.65

To determine the feasibility of venting fission gases from a liquid Pu alloy fuel to Na, open capsules containing the fuel were immersed in flowing Na at 600 and 650°C. In some instances the fuel and Na were in contact; in others, a helium buffer was interposed. Container materials were Ta and a Ta–5W alloy with and without an internal coating of TaC. Pu losses from capsules without a TaC layer were excessive after test times as short as 1000 hr. The addition of the TaC layer reduced Pu losses to an estimated 10^{-4} to 10^{-5} of the original inventory per year. Author (NSA)

N68-17267*# Aerojet-General Corp., Azusa, Calif.
NUCLEAR ENGINE ANALYSIS PROGRAM. VOLUME 1: TECHNICAL DISCUSSION AND PROGRAM NOMENCLATURE. NERVA PROGRAM
Dec. 1964 140 p refs
(Contract SNP-1)
(NASA-CR-91269; RN-S-0171; TID-23654) CFSTI: HC $3.00/MF $0.65 CSCL 21F

The Nuclear Engine Analysis Program is an IBM 7094 digital computer program which simulates the steady-state operation of the NERVA hot-bleed engine over the full operational range of chamber pressures and temperatures. This program computes the energy balances for all engine components and for the entire engine, as required to satisfy the demanded chamber pressure and temperature. The program output consists of temperatures, pressures, and flow rates throughout the system. In addition, program output such as the turbine inlet temperature, turbine flow rate, hot-bleed flow rate, diluent flow rate, turbopump speed, pump specific speed, turbine power control valve position, nuclear power, engine thrust and specific impulse is obtained. The program is presently in production status and is being used extensively for steady-state analyses of the NERVA engine systems. Author (NSA)

N68-17271*# Aerojet-General Corp., Azusa, Calif.
TRANSIENT ENGINE SIMULATION PROGRAM. NERVA PROGRAM
W. Madsen, R. Steiger, and H. Hutchison Aug. 1964 220 p
(Contract SNP-1)
(NASA-CR-91272; RN-S-0114; TID-23639) CFSTI: HC $3.00/MF $0.65 CSCL 21F

The Transient Engine Simulation Program showing logic, the derivation of equations and operating instructions are given. The program calculates metal and fluid temperatures and stagnation pressure distributions as functions of time and distance. The overall engine system is represented by combining several separate existing mathematical models of engine subsystems (e.g., turbopump, reflector, shield, core, nozzle, hot-bleed port). The program is general and capable of handling design modifications. Program accuracy is shown to be a direction function of input. Good agreement with NRX-A1 and other test data has been shown. The program is in production and is coded in SCAT for the IBM 7094 computer using the Aerojet Kismet monitor. Author (NSA)

N68-17289*# Aerojet-General Corp., Azusa, Calif.
PERFORMANCE CHARACTERISTICS OF ETS-1 NUCLEAR EXHAUST SYSTEM. NERVA PROGRAM Final Report
Oct. 1964 78 p refs Revised
(Contract SNP-1)
(NASA-CR-91275; RN-S-0099; TID-22929) CFSTI: HC $3.00/MF $0.65 CSCL 21F

An ejector system for Engine Test Stand-1 (ETS-1) at Nevada Rocket Development Site (NRDS) was selected at the completion of the testing and analysis program of CY 1963. During the CY 1964 program, this selected ejector system was subjected to a series of system performance analysis tests to provide an operational map, as well as a high level of confidence in the prediction of operation of the Nuclear Exhaust System (NES) at NRDS. Ejector system performance analysis tests were first conducted using a 1/8 scale model system. A 1/4-scale model ejector system was built and tested to verify the scaling parameters used and, consequently, to increase the confidence level of the performance predications of the full-scale ejector system. The data were analyzed and compared with the 1/8-scale data. Data agreement was considered to be very good in all areas, therefore, there is high confidence in the prediction of performance and operation of the NES. Author (NSA)

N68-17292# Atomics International, Canoga Park, Calif.
LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC) Quarterly Progress Report, Jul.–Sep. 1967
30 Oct. 1967 105 p refs
(Contract AT(29-2)-2338)
(NAA-SR-12578; QPR-1) CFSTI: HC $3.00/MF $0.65

Analyses have been accomplished on the shrink-fit of the capsule structural shell to the inner fuel assembly, the pressure restrictions on the helium under the Pt-10Rh clad and the pressure–electrical feedthru design. The reference and creep test capsule designs have been completed and drawings released. Fabrication techniques have been specified for each of the capsule piece parts. Screening tests have been completed for the braze alloys in the pressure-electrical feedthru assembly. Also preliminary results from feasibility tests indicate back extrusion may provide a suitable backup to deep drawing of the T-111 structural shell. Fabrication and assembly tooling designs have been initiated and the preliminary weld development and quality assurance plans completed. Preliminary results from the coating development tests show that α(alpha) phase Al_2O_3 can be laid down by chemical vapor deposition. Preliminary indications are that a repeatable Al_2O_3 coating process without undue contamination of the substrate

is feasible. The design of the coupon compatibility stacks started. The heater and vacuum systems for the coupon compatibility tests are being modified and checked out. Modification designs for the creep test heater and vacuum systems are in progress. Design of the helium pressure system for creep testing is completed and fabrication of the system has started. Alternate methods of measuring in-test strain are being evaluated. Author (NSA)

N68-17293 European Atomic Energy Community, Ispra (Italy).
DESCRIPTION OF IBM 360 COMPUTER PROGRAM FOR THE CALCULATION OF LIQUID COOLED 7-ROD CLUSTER FUEL ELEMENTS
W. Eifler, R. Nijsing, and J. Airola. 1968. 32 p. refs.
(EUR-3733.E) CFSTI: $3.00

A calculation model taking account of the various heat transfer phenomena occurring in cluster-type finned fuel elements was described in *Nuclear Engineering and Design*, 4 (1966). The numerical examples given there were calculated employing an IBM 360 computer program. The present document presents a description of the program. First, the general features of this program are outlined. Subsequently the single parts are described. A complete listing of the program is given. Author

N68-17296*# Aerojet-General Corp., Sacramento, Calif.
AEC-NASA SPACE NUCLEAR PROPULSION OFFICE INSTRUMENTATION EVALUATION NRX-A2 TESTS
Feb. 1965. 118 p. refs.
(Contract SNP-1)
(NASA-CR-91273; RN-S-0193) CSCL 21F

Four engine mounted pressure transducers of the linear variable differential transformer (LVDT) type were located on the engine to monitor NRX-A2 engine pressure. The transducers used were backed up by test-car-mounted, non-nuclear hardened, pressure transducers. The resulting test-car-mounted data were used as the standard pressure data for correlating engine mounted pressure transducer data. The performance of the engine mounted transducers on NRX-A2 was used as the basis for the selection of the LVDT pressure transducers for use on NRX-A3. Author

N68-17307# European Atomic Energy Community, Ispra (Italy).
OPTIMIZATION OF CONTROL SYSTEMS BY AN ANALOG METHOD
A. Garroni and A. Lucia. Jan. 1968. 26 p. refs.
(EUR-3735.E) CFSTI: HC $3.00/MF $0.65

This report describes a method of optimizing the operation of a plant subject to random disturbances whose effect can be decreased by means of suitable non-linearities inserted in the feedback chain. The system is subjected to random stationary perturbations and is optimized under operating conditions, in the steady state, by minimizing a functional consisting of a linear combination of mean quadratic values and mean moduli of a few significant parameters. By using analog techniques to solve the dynamic equations of the system, in which the perturbations (whose spectral distribution has been determined in a preliminary plant analysis) are introduced as perturbing signals, the functional is obtained in terms of the parameters of the non-linearities. A minimum condition can thus be readily pinpointed. The method is applied to problems in nuclear reactor control. Author

N68-17313*# Aerojet-General Corp., Azusa, Calif. NERVA Systems and Controls Dept.
DEVELOPMENT OF NERVA COPPER-CONSTANTAN IMMERSION THERMOCOUPLES. NERVA PROGRAM
H. C. Chandon. Dec. 1964. 104 p. refs.
(Contract SNP-1)
(NASA-CR-91271; RN-DR-0044; TID-23653) CFSTI: HC $3.00/MF $0.65 CSCL 18D

The development of immersion type copper-constantan thermocouples for NRX A2 testing is reported. All significant analyses and testing performed during the development of the copper-constantan thermocouples and the test results are described. Author (NSA)

N68-17314*# Aerojet-General Corp., Azusa, Calif.
NES EXHAUST PLUME SCALE MODEL MEASUREMENTS AND FULL SCALE PREDICTIONS. NERVA PROGRAM
Nov. 1964. 29 p. refs.
(Contract SNP-1)
(NASA-CR-91270; RN-S-0168; TID-23650) CFSTI: HC $3.00/MF $0.65 CSCL 21F

The predicted full-scale NES exhaust plume length and exhaust plume thermal radiation flux at proximate surfaces, and the methods used to predict full-scale flame length and thermal radiation from scale-model data are described. Also presented are experimental values of scale-model NES exhaust-plume length, exhaust-plume thermal radiation flux at proximate surfaces, and exhaust-plume emittance. Author (NSA)

N68-17320# Mainz Univ. (West Germany).
SEVENTH TECHNICAL MEETING OF THE DEUTSCHES ATOMFORUM E.V. "REACTOR THEORY" [FACHTAGUNG DES DEUTSCHEN ATOMFORUMS E.V. "REAKTOR-THEORIE"]
1967. 100 p. refs. In GERMAN. Conf. held in Mainz, 5–7 Apr. 1967
(CONF-670431)

Abstracts of the papers presented at the Seventh Technical Meeting are compiled. The topics discussed were calculation of fast and thermal reactors, theory of heterogeneous reactors, reactor shielding, transport theory, short- and long-time behavior of reactors, theoretical analysis of experimental methods and results, and mathematical methods. The complete text of one paper was presented: "Boundary Conditions for the Neutron Flux in the Cylinderizing of Hexagonal and Quadratic Cells". For preparation of S_n calculation with the Winfrith S_n program, the effect of cylinderization of a hexagonal or quadratic cell in combination with the boundary condition "white" must be considered. The size of the effect and the methods to correct errors in ϕ_1/ϕ_0 must be determined. A theoretical analysis led to the conclusion that cylinderization leads to too small a value of ϕ_1/ϕ_0. The error lies between 0 and 8%. The effect is larger for quadratic cross sections than for hexagonal cross sections. Cylinderization in combination with "reflecting" boundary conditions leads to too large a value of ϕ_1/ϕ_0. The use of a mixed "white-reflecting" boundary condition in S_n calculations gives better results. NSA

N68-17323# General Electric Co., Sunnyvale, Calif. Advanced Products Operation.
TERMINAL EXAMINATION AND EVALUATION OF EVESR MARK 2 ANNULAR SUPERHEAT FUEL
G. J. Rittenmyer. Sep. 1967. 96 p. refs.
(Contract AT(04-3)-189)
(GEAP-5510) CFSTI: HC $3.00/MF $0.65

The experimental fuel designated Mark II was irradiated as part of the EVESR Nuclear Superheat Fuel Development Program. The initial loading of this fuel in EVESR consisted of 32 bundles, each composed of nine fuel rods. The Mark II fuel tests were designed primarily as a cladding materials test. On the basis of previous out-of-pile work, five test cladding materials were selected: Incoloy-800, Inconel-600, Types-310 and -304 vacuum melted stainless steels, and Type-304 commercial grade stainless steel. Results of post-irradiation examinations of lead fuel rods clad with these five test materials following shutdown of the reactor are documented. Author (NSA)

N68-17324# Idaho Nuclear Corp., Idaho Falls.
USE OF THE ARMF FOR A FAST REACTOR SUPPORT PROGRAM

E. Fast, C. L. Beck, D. A. Millsap, R. G. Nisle, J. W. Rogers, et al. Nov. 1967 66 p refs
(Contract AT(10-1)-1230)
(IN-1143) CFSTI: HC $3.00/MF $0.65

Calculations show that flux spectra approximating those of fast reactors can be generated in a relatively small region in the center of the ARMF. Adequate sensitivity is available for making reactivity measurements of the usual small samples. The proposed concept also permits component parts of the fast flux core to be varied, thus producing a range of spectra. Specimens may be irradiated in an intense fast flux environment in a flux converter-thermal filter capsule. A simple converter tube facility with a UO_2 shielded sample volume was used to obtain preliminary measurements for comparison with calculations. Reactivity values were obtained with 17 specimens, mostly metals, including stainless steels and natural uranium. A 26-group one-dimensional diffusion code gave results that were in reasonable agreement with experiment in most cases. A proton-recoil spectrometer has been built for measurement for the keV–MeV neutron energy spectrum providing independent information to check calculations. Author (NSA)

N68-17348# Japan Atomic Energy Research Inst., Tokyo.
DETECTION OF FAILED FUEL AT JPDR
Kiyoshi Makino. Nov. 1967 26 p refs
(JAERI-1147)

An abnormally high level of radioactivity was detected in the off gas system on December 22, 1964. The source of this high radioactivity was fission products, including Kr 85 ,n, Xe 133, and Xe 135, and this phenomenon was considered to be due to the fuel (failed fuel) which was releasing fission products into the coolant in the reactor core. After burning the core fuel for about one more year, various tests were carried out on the location and detection of failed fuel in the reactor core. As the results of the tests, a swaged fuel assembly was removed from the core as the assembly containing such failed fuel. Results of the tests are described. Author

N68-17399# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
DATATRAN: THE INPUT LANGUAGE FOR THE NOVA MODULAR PROGRAM SYSTEM. BASIC PHILOSOPHY AND EXPERIENCE
[1967] 7 p refs Presented at the Appl. Math. Div. Colloq., Argonne, Ill.
(Contract W-31-109-ENG-52)
(KAPL-P-3372; CONF-670830-1) CFSTI: HC $3.00/MF $0.65

The description of the input language for the NOVA module system for reactor design is presented. The inter-module communication using DATATRAN allows programs to be written and tested rapidly. NSA

N68-17432 Societe Alsthom, Paris (France).
PROGRAM CIRE [PROGRAMME CIRE] Final Report
Brussels EURATOM Dec. 1967 102 p In FRENCH
(Contract EURATOM-080-66-5-TEEF)
(EUR-3665.F) CFSTI: $3.00

A dynamics code CIRE is described which can be used to study transients in BWR resulting from imposed time variations in reactivity introduced by control rods motion, and in coolant flow, inlet enthalpy and mean pressure. The core is represented by channels in parallel where flow distribution is determined as a function of liquid coolant height, frictional resistances and void distribution in each channel. Finite difference models are used in: (1) treatment of reactor kinetics, (2) calculation of variations of fuel element and can temperature distribution, and (3) determination of heat flux and void distributions. Reactivity feed backs from coolant and fuel temperature as well as void reactivity contribution are determined by integrals over the core volume. Provision is also made for slip ratio and variations of boiling boundary in calculational procedure. Output provides axial distribution of heat flux, void fraction, coolant, fuel and can temperatures as well as location of boiling boundary in each channel, as functions of time. The code is written in Fortran IV for use on the IBM 7094 or IBM 360. Author

N68-17436# Japan Atomic Energy Research Inst., Tokyo.
OUTLINE OF CRITICAL EXPERIMENT AND CHARACTERISTIC TEST OF JRR-4
1967 28 p refs In JAPANESE
(JAERI-1139)

The Japan Research Reactor-4 (JRR-4) is a swimming pool type reactor with a thermal power of 1000 kW and uses light water as the coolant and moderator. The fuel elements consist of planes of a 90% enriched uranium-235 aluminum alloy. A critical experiment and characteristic tests of the JRR-4 are described. The tests include control rod calibrations; thermal flux measurement; mass, void, and temperature coefficient measurements; and power up and full power tests. Author

N68-17535# Joint Publications Research Service, Washington, D. C.
SOVIET ATOMIC ENERGY RESEARCH
15 Feb. 1968 47 p refs Transl. into ENGLISH from At. Energy (Moscow), v. 23, no. 6, Dec. 1967 p 503–511, 549–552, 561–564
(JPRS-44390) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. EXPERIMENTS ON THE BR-5 REACTOR FOR THE PERIOD 1959–1966 A. I. Leypunskiy, V. V. Orlov, M. S. Pinkhasik, N. N. Aristarkhov, I. A. Yefimov, et al p 1–19 (See N68-17536 08-22)
2. B-2 INTERMEDIATE NEUTRON BEAM CONVERTER OF THE BR-5 REACTOR A. D. Lupinov, V. P. Mashkovich, A. N. Nikolayev, Yu. N. Podsevalov, V. P. Polivanskiy, et al p 20–27 refs (See N68-17537 08-22)
3. ASYMPTOTIC PN APPROXIMATION V. S. Shulepin p 28–31 refs (See N68-17538 08-24)
4. FORMATION OF Pu^{238} BY NEUTRON IRRADIATION OF U^{235} AND Np^{237} p 32–40 refs (See N68-17539 08-24)

N68-17536# Joint Publications Research Service, Washington, D. C.
EXPERIMENTS ON THE BR-5 REACTOR FOR THE PERIOD 1959–1966
A. I. Leypunskiy, V. V. Orlov, M. S. Pinkhasik, N. N. Aristarkhov, I. A. Yefimov, et al. *In its* Soviet Atomic Energy Res. 15 Feb. 1968 p 1–19 (See N68-17535 08-22)

Operational experience with the BR-5 reactor showed that sodium is a convenient coolant to use, and that Cs^{137} (fission product of plutonium) and Na^{22} are the isotopes which determine the residual activity of the coolant in the BR-5 reactor after the decay of Na^{24}. Studies of the power effects of the reactivity and different effects contributing to the power coefficient of the reactivity showed that the kinetics of a fast reactor do not differ from the kinetics of thermal reactors. Tabulated data are presented on the power and temperature conditions for operation, and the reasons for reactor shutdown and operation of emergency shielding are analyzed. Also discussed are pump operation and maintenance, heat exchanger operation, liquid metal equipment operation, and techniques for controlling the hermetic state of the fuel element cans and radioactive contamination of the loop. Data are included to show the maximum activity of fission products and products of the activation of sodium in the first loop at different periods of reactor operation. M.G.J.

N68-17537# Joint Publications Research Service, Washington, D. C.
B-2 INTERMEDIATE NEUTRON BEAM CONVERTER OF THE BR-5 REACTOR

A. D. Lupinov, V. P. Mashkovich, A. N. Nikolayev, Yu. N. Podsevalov, V. P. Polivanskiy et al. *In its* Soviet Atomic Energy Res. 15 Feb. 1968 p 20-27 refs (See N68-17535 08-22)

To study the attenuation of intermediate neutrons in different shielding assemblies, a B-2 intermediate neutron beam iron converter was constructed. The use of iron in constructing the converter is based on the fact that attenuation of fast neutrons in iron differs considerably from the attenuation of the intermediate neutrons of the reactor. The spectral-angular distribution of the scattered and unscattered neutrons at the outlet of the converter was calculated, based on neutron passage from the unidirectional source of the B-2 beam through iron. Neutron distributions in water were also obtained. Measurement results established that in a shielding thickness corresponding to a multiplicity factor of attenuation of $\approx 10^4$, neutrons of intermediate energies are determined in the neutron spectra. At the water/converter interface, two processes are observed: fast attenuation of neutrons with energies up to 100 kev, and intensive accumulation of thermal and slow neutrons. M.G.J.

N68-17568*# General Electric Co., Schenectady, N. Y. Advanced Technology Labs.

FEASIBILITY STUDY—APPLICATION OF FLUID AMPLIFIERS TO REACTOR ROD CONTROL Final Report

W. A. Boothe. 25 Nov. 1963 97 p Revised

(Contract NAS3-2567)

(NASA-CR-54005; GE-63GL134) CFSTI: HC $3.00/MF $0.65 CSCL 18D

The study shows that it is feasible to use fluid amplifiers to replace the electronic portions of electropneumatic drives for reactor rod control systems. The fluid amplifiers and associated circuit elements are reasonable in size and gas consumption. Several methods of controlling power flow to the actuator were considered, including one vortex valve circuit with no moving parts. Indications are that this will have low efficiency. A simplified version of the present single stage electropneumatic valve is recommended for adaptation to fluid amplifier operation. Author

N68-17637# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. Nuclear Engineering Test Facility.

FUEL PLATE TEMPERATURE STUDIES AT THE AIR FORCE NUCLEAR ENGINEERING TEST FACILITY Technical Report, 1 Mar. 1966-1 Jun. 1967

Frederick B. Buoni (M.S. Thesis—Ohio State Univ.) 5 Jul. 1967 91 p refs

(AFIT-TR-67-9; AD-663921)

Fuel element temperatures are measured and the data are analyzed to determine the limiting power of the AF-NETF due to these fuel temperatures. The limits are 15 megawatts from loss of flow accident conditions, 20 megawatts from loss of power accident conditions and 25 megawatts from steady state considerations alone. Author (TAB)

N68-17661# Institut za Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).

NUMERICAL CALCULATION PROCEDURE FOR CRITICALITY PARAMETERS OF THE TWO ZONE REFLECTED REACTOR WITH FLAT CENTRAL ZONE

T. Bosevski and P. Strugar. Oct. 1966 7 p refs

(IBK-466)

The Newton method for solving a system of two non-linear equations is presented. The non-linear equations are obtained in determining the criticality parameters for a two-zone reactor with flat central zone. NSA

N68-17665# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung.

SYSTEMS ANALYSIS OF A FAST STEAM COOLED REACTOR OF 1000 MW(e)

W. Frisch, F. Hofmann, E. Kiefhaber, H. Moers, K. Schramm et al. Oct. 1967 24 p refs Presented at IAEA Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, Germany, 30 Oct.-3 Nov. 1967

(EURFNR-405; EUR-3680.E; KFK-636; CONF-671043-5) CFSTI: HC $3.00/MF $0.65

The Karlsruhe design of a steam cooled fast reactor (D1) has been the subject of a systems analysis. The dependence of fuel inventory, breeding ratio, rating, core geometry and plant efficiency on coolant pressure, and coolant temperature has been studied for two different rod powers. The effect of artificial surface roughness has been investigated. For some configurations the resulting fuel cycle and capital costs have been determined and discussed. The main influence results from pressure. The lower pressure allows for higher breeding ratios, but lower efficiencies and vice versa. From this the fuel cycle costs show an optimum in the range of 150 ata. The capital costs on the other side decrease with pressure. The overall optimum of the power generating costs for the presently studied parameter range is at about 170 ata, a coolant outlet temperature of 540°C and a rod power of 420 W/cm. Artificial roughness (boundary layer type) leads for a required system pressure and outlet temperature to a larger coolant volume fraction, and, therefore, to reduced breeding ratios, but higher efficiencies. Some stability characteristics of the cores have been studied. The dependence of the core stability on the varied parameters is shown. Author (NSA)

N68-17667# Institutza Nuklearne Nauke (Boris Kidric), Belgrade (Yugoslavia).

CONTINUAL EXCHANGE OF FUEL IN REACTOR WITH THE FLAT CENTRAL ZONE

T. Bosevski, P. Strugar, and J. Pop-Jordanov. Mar. 1967 23 p refs

(IBK-532)

An improved calculation procedure for continual fuel exchange in natural U fuel reactors is presented. The reactor configuration has two-zone with a flat central zone. By using continual fuel exchange the flattening of the thermal neutron flux in the central reactor zone can be achieved. NSA

N68-17675# Aktiebolaget Atomenergi, Stockholm (Sweden).

MEASUREMENT OF THE DECAY OF THERMAL NEUTRONS IN WATER POISONED WITH THE NON-1/V NEUTRON ABSORBER CADMIUM

L. G. Larsson and E. Moeller. Jan. 1968 20 p refs

(AE-309) CFSTI: HC $3.00/MF $0.65

Measurements have been made of the decay constant of thermal neutrons in water poisoned with the non-1/v absorber cadmium. An experimental method has been used in which proper spatial integration of the neutron flux enables data, representative of the infinite medium to be accumulated without waiting for the establishment of a fundamental mode distribution. The change in effective cross section with concentration of the dissolved cadmium, $d\sigma_{eff}/dN$, has been determined for infinite medium at 20°C. Two- and three-parameter fits of the decay constant yield $-(0.32 \pm 0.09) \times 10^{-17}$ barn cm^3 and $-(0.47 \pm 0.10) \times 10^{-17}$ barn cm^3, respectively. Earlier published measurements have resulted in two to five times larger values, whereas a published calculated value for Nelkin's model is -0.33×10^{-17} barn cm^3. Author

N68-17794 Atomic Energy Commission, Washington, D. C. Reactor Development Div.

NUCLEAR ENERGY SOURCE LIMITATIONS FOR DYNAMIC ENERGY CONVERSION SYSTEMS

Frank K. Pittman and Joseph D. Lafleur, Jr. *In* AGARD Combust. and Propulsion 1967 p 5-23 refs (See N68-17793 08-03)

The limitations which the nuclear energy source imposes on the dynamic power system fall into two categories. First, because of the premium which the space environment places on high temperature operation, materials throughout the system are

called on to operate at high temperatures. Since the heat source must operate at the highest temperature of the cycle, the reactor fuel temperature is a potential limitation on cycle performance. Second, the nuclear radiation which accompanies the release of nuclear energy will require shielding or "hardening" to reduce the harmful effects on spacecraft components, and shielding to prevent injury to crews. The nuclear power plants will be the best, and in many cases, the only, means of meeting future space power needs. Therefore, these limitations and the associated development problems have been identified and are being solved. Author

N68-17803 TRW Space Technology Labs., San Bernardino, Calif.
NUCLEAR SOURCE LIMITATIONS FOR DIRECT CONVERSION DEVICES
R. W. Bussard *In* AGARD Combust. and Propulsion 1967 p 257-277 refs (See N68-17793 08-03)

Nuclear energy sources from solid-fuel fission reactors to eventual fusion reactors are considered for application to direct conversion. Brief review of system operating requirements provides a background for assessment of the potentialities and inherent physical limitations of these sources for direct conversion. Emphasis is placed on the characteristics of solid-fuel and gaseous-fuel fission reactors for application to thermionic and MHD conversion systems. Author

N68-17918# Naval Research Lab., Washington, D. C. Reactor Materials Branch.
IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS Quarterly Progress Report, 1 Aug.-31 Oct. 1967
J. Russell Hawthorne, Charles Z. Serpan, Jr., Uldis Potapons, and Henry E. Watson 15 Nov. 1967 52 p refs
(NRL-MR-1833; AD-663888)

The research program of the NRL Metallurgy Division, Reactor Materials Branch, is devoted to the determination of the effects of nuclear radiation upon the properties of structural materials. The overall program is sponsored by the Office of Naval Research, the Naval Ship Systems Command, the U.S. Atomic Energy Commission, and the Army Nuclear Power Program. Since research findings which apply to the objectives of one sponsoring agency are also of interest to the others, the overall program progress is reported herein. This report, covering research for the period 1 August 1967 - 31 October 1967 includes the following: (1) an evaluation of sulfur and phosphorus content as radiation embrittlement sensitivity variables in A302-B steel, (2) the radiation embrittlement of 12Ni-5Cr-3Mo maraging steel and companion weld metal at 250 deg F and at elevated temperatures, (3) the radiation embrittlement resistance of LaCrosse Reactor pressure vessel plate and test weldment, (4) an evaluation of irradiated Big Rock Point Reactor surveillance materials, (5) the notch ductility characteristics of service-irradiated, PM-2A reactor pressure vessel steel, and (6) the installation and calibration of a new, remotely operated Charpy-V impact machine. Author (TAB)

N68-17942# Naval Research Lab., Washington, D. C.
AVAILABILITY OF DATA ON IRRADIATED MATERIALS AS RELATED TO DESIGN REQUIREMENTS FOR WATER COOLED REACTOR PRESSURE VESSELS Final Report
J. R. Hawthorne and F. J. Loss 1 Aug. 1967 41 p refs Presented at the ASTM Symp. on Effects of Radiation on Structural Metals, 1966 Sponsored in part by AEC
(NRL-6625; AD-663879)

NRL has completed a survey of known experimental programs which have contributed to and are attempting to satisfy the data requirements necessary for the development of nuclear reactor pressure vessel specifications and operations. Designer requirements have been set forth in the report Properties of Irradiated Materials Needed for the Design of Reactor Vessels, by D. W. McLaughlin which was presented as an ASME Research Committee report to the 1966 ASTM Symposium on Effects of Radiation on Structural Metals. This report was the primary reference used in weighing the presentation of data availability against designer requirements. An analysis of individual material properties and problem areas is presented rather than an extensive data compilation. The areas considered are low-cycle and high-cycle fatigue, brittle fracture resistance (transition temperature characteristics and fracture mechanics), static load strength, and recovery of original properties. Author (TAB)

N68-17985# Japan Atomic Energy Research Inst., Tokyo.
COMPUTER CONTROL OF THE STARTUP OF A NUCLEAR REACTOR
Takeo Fujisawa, Hideo Koshii, and Koichi Watanabe 1968 22 p refs In JAPANESE; ENGLISH summary
(JAERI-1152) CFSTI: HC $3.00/MF $0.65

In designing a computer control system, the determination of a sampling-rate is a fundamental problem, since the control system is essentially based on sampling principles and the system behavior is directly influenced by the sampling-rate. To give a clue for its determination, a description is given of the dependence of the critical loop gain and integral square error on the sampling-rate of the control system. The effect of reactivity change-rates is also described for realizing the optimum startup control of a reactor. An experiment was made on the computer control of the startup of the JRR-1 reactor for various set values of reactor periods, power levels and sampling-rates. Tests of reactivity insertion as disturbance were successfully conducted in the experiment to show the sufficient stability and applicability of the direct digital control system. Author

N68-17989# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF RADIOLUMINESCENCE ALKALI HALIDE CRYSTALS IN THE HORIZONTAL CHANNEL OF A REACTOR [ISSLEDOVANIYE RADIOLYUMINESTSENTSII SHCHELOCHNOGALOIDNYKH KRISTALLOV NA GORIZONTAL'NOM KANALE REAKTORA]
K. K. Shvarts, D. Yu. Lusis, and Yu. A. Ekman *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 1-9 refs (See N68-17988 08-26)

The temperature dependence of the intensity of radioluminescence and the kinetics of the flare-up of radioluminescence and thermoluminescence of KCl-Tl, KBr-Tl, KI-Tl and CsI-Tl crystals in the temperature interval 300-600°K are studied during excitation by radiation of the [IRT] reactor. The results obtained during excitation by reactor radiation and X-rays are compared. Author

N68-17993# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MEASURING THE FLUXES OF FILTERED RADIATION OF A REACTOR [IZMERENIYE POTOKOV FIL'TROVANNOGO IZLUCHENIYA REAKTORA]
K. K. Baltmugur and D. Ya. Gubatova *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 41-44 refs (See N68-17988 08-26)

The results of measuring the fluxes and doses of neutrons and gamma rays at the output of a horizontal experimental channel of an IRT reactor are given. The channel is equipped with a system of special filters that can vary the ratio of different components of reactor radiation. Author

N68-18037# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. Nuclear Engineering Test Facility.
PRIMARY COOLANT CONDUCTIVITY STUDY
John W. Baker, Anthony N. Fasano, Laszlo B. Hary, and Frederick B. Buoni 19 Jun. 1967 16 p
(AFIT-TR-67-8; AD-663923)

The AF NETF, a 10 MW water-cooled research reactor, monitors the conductivity of its coolant to detect erosion/corrosion

of its structural systems and fuel element failure. When a gradual increase in this conductivity sent it above the defined limit, a study was initiated to identify the contaminants and examine the source and removal processes. The major contaminant, Na23, was traced to an in-leakage from the secondary to the primary coolant systems through the heat exchanger interface. Minor amounts of contaminant were introduced from a deluge tank and from residual ions remaining on the demineralizer from the factory NaOH flush. The study proved the absence of any fuel cladding defect and the presence of only an acceptably minimal structural erosion/corrosion rate. The in-leakage source was identified and corrected. The demineralizer system was found to be adequate for normal operation, but economically restrictive during the latter portion of resin life.
TAB

N68-18174*# National Aeronautics and Space Administration, Washington, D. C.
USE OF A GAS UNDER VARIABLE PRESSURE TO CONTROL REACTIVITY IN POWER REACTORS
M. Lagrange, L. Dolle, J. P. Satre, and G. Dirian Mar. 1968 36 p refs Transl. into ENGLISH from the book "Utilisation d'un Gaz Absorbant pour Obtenir un Controle de la Reactivite dans les Reacteurs de Puissance" (France) p 733–769
(NASA-TT-F-11373) CFSTI: HC $3.00/MF $0.65 CSCL 18I

Described is a hairpin shaped circuit that transverses the reactor and registers the progressive degassing of the moderator gas tube in the reactor core. In order to control the reactivity of the absorbing gas, an auxiliary circuit submerges in the core and isolated the gas from the moderator. Control strength variations in the gaseous bank are obtained by modification of the absorbing gas mass in that part of the circuit which is located in the core. Activated pressure valves in turn supply the needed gas flow for the reactor moderator.
G.G.

N68-18184*# Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
SHIELDING STANDARD DESIGN METHOD Second Status Report
1 Mar. 1967 91 p refs
(Contract SNP-1)
(NASA-CR-93368; WANL-TME-1466) CFSTI: HC $3.00/MF $0.65 CSCL 18F

This method, designated Shielding Standard Design Method II (SSDM-II), is the second generation of methods which has evolved from evaluating comparisons of calculated versus experimental radiation enviroment data. SSDM II employs three widely used analytical techniques: Monte Carlo, S_n transport, and point kernel. Extensive comparisons of SSDM II calculated data with NRX experimental data and other applicable experimental data are presented. The experimental data include internal and external reactor gamma ray dose rates, external fast neutron and thermal neutron environment, and liquid H_2 propellant heating data. Improvements, which are described in detail include: (1) replacing the transport code with the two dimensional transport code for more accurate calculation of neutron fluxes, and (2) replacing the 14-0 point kernel code with the WANL KAP point kernel code. Two unique neutron–photon S_n transport code system (for one and two dimensional analysis) are being developed. Application of the S_n transport to photon transport analysis is expected to facilitate radiation analysis of reactor-shield systems.
Author (NSA)

N68-18197*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRELIMINARY CONSIDERATIONS FOR FAST-SPECTRUM, LIQUID-METAL COOLED NUCLEAR REACTOR PROGRAM FOR SPACE-POWER APPLICATIONS
Gerald P. Lahti, Edward Lantz, and John V. Miller Washington Mar. 1968 49 p refs
(NASA-TN-D-4315) CFSTI: HC $3.00/MF $0.65 CSCL 18L

A preliminary study was made in which reactor size and shield weight requirements were calculated for several compositions of uranium nitride and uranium dioxide fuel materials under various operating conditions. A fast-spectrum, lithium-cooled reactor was selected for the study since it potentially will result in the smallest reactor that is capable of operating at the required temperature levels. In order to determine man-rated shielding requirements, a 2-millirem-per-hour radiation dose at 66 feet was selected as a reasonable value, being of the same order of magnitude as that which would be received from galactic cosmic rays in interplanetary space. Nuclear criticality and the allowable fuel burnup limits essentially determine the required reactor size and resulting weight of the shielding. The importance of the other variables, such as allowable steady-state heat-transfer limits, coolant temperatures, flow rates, and coolant hole sizes, is only secondary in determining the weight of the reactor plus shield. Choice of the proper value for each of these parameters can be based on overall system performance, availability of design data, material limitations, and manufacturing feasibility. It appears that nuclear stability and control, fuel material development, and shielding optimization are areas requiring further study.
Author

N68-18243*# United Aircraft Corp., East Hartford, Conn.
CONTAINMENT EXPERIMENTS IN VORTEX TUBES WITH RADIAL OUTFLOW AND LARGE SUPERIMPOSED AXIAL FLOWS
John S. Kendall, Arthur E. Mensing, and Bruce V. Johnson Washington Mar. 1968 92 p refs
(Contract NASw-847)
(NASA-CR-993; F-910091-12) CFSTI: HC $3.00/MF $0.65 CSCL 21F

An experimental investigation was conducted to determine the heavy-gas containment characteristics of radial-outflow vortexes for potential application to a vortex-stabilized, open-cycle gaseous nuclear rocket engine. Tests were conducted in a constant-temperature vortex with Reynolds numbers based on the superimposed axial flow up to those expected in a full-scale engine. Air was employed to simulate the seeded hydrogen propellant and a heavy fluorocarbon was used in most tests to simulate the gaseous nuclear fuel. The effects on heavy-gas containment of changes in the vortex tube length-to-diameter ratio, the light-gas injection geometry and area, the ratio of average heavy-gas density to light-gas density, and the density of the heavy gas at injection were studied. The containment parameters varied significantly only with vortex tube length-to-diameter ratio and the ratio of average heavy-gas density to light-gas density. The results of some tests using helium injected near the centerline of the vortex indicated that the presence of a light gas in the central region of the vortex has a significant favorable effect on containment characteristics.
Author

N68-18252*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FEASIBILITY STUDY OF A TUNGSTEN WATER MODERATED NUCLEAR ROCKET. 7: SYSTEM DYNAMICS AND CONTROL ANALYSIS
James R. Mihaloew Washington Mar. 1968 98 p refs
(NASA-TM-X-1426) CFSTI: HC $3.00/MF $0.65 CSCL 21F

A system dynamics and control analysis was performed on several versions of a tungsten water-moderated (TWMR) nuclear rocket system, to determine its overall feasibility and control requirements from chilldown to startup and power range operation. Results of steady-state mapping of the TWMR showed that heat exchanger hydrogen bypass was required to prevent icing in the water-moderator cooling heat exchanger. A comparative system analysis of the several TWMR versions showed that the all-topping cycle version with heat exchanger bypass was substantially superior with respect to system simplicity and flexibility at the design chamber pressure of 600 psia. However, a split-feed cycle version with heat exchanger bypass represented the most promising system because of its superior chamber pressure uprating potential. The

control analysis of this version showed that chamber temperature control with a poison insertion–extraction scheme was extremely fast in response, but necessarily discontinuous. Chamber temperature control with heat exchanger bypass was comparatively slow but inherently continuous. A control system based on heat exchanger bypass for primary chamber temperature control and poison reactivity for augmentation was demonstrated satisfactorily over a typical operating cycle. Author

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N68-17260# Groningen Rijksuniversiteit (Netherlands). Institut voor Theoretische Fysica.
NONRELATIVISTIC APPROXIMATIONS OF THE DIRAC HAMILTONIAN
E. de Vries Aug. 1966 30 p refs
(NP-17121; IR-69)

Methods for obtaining approximate expressions for the Dirac Hamiltonian for the case $v/c << 1$ are compared. Difficulties encountered in these methods are discussed. The Hamiltonian to order $(v/c)^6$ was calculated with one of these methods. NSA

N68-17268*# Pennsylvania State Univ., University Park. Materials Science Dept.
SIMULTANEOUS DETERMINATION OF REFRACTIVE INDEX AND THICKNESS OF VERY THIN FILMS BY ELLIPSOMETRY
Raghuvir Rai (M.S. Thesis) Dec. 1967 78 p refs
(Grant NGR-39-009-042)
(NASA-CR-93174) CFSTI: HC $3.00/MF $0.65 CSCL 20F

In ellipsometry, the case of light incident from a dense medium-like liquid onto a film over an abosrbing substrate was studied theoretically for the two cases: when the angle of incidence ϕ_0 is less than the critical angle ϕ_c and when ϕ_0 is greater than ϕ_c. Calculations have indicated that the sensitivity with which the thickness of the film with an assumed refractive index can be measured is nearly the same whatever be the first medium for the case when ϕ_0 is less than ϕ_c. When ϕ_0 is greater the ϕ_c, the sensitivity is poor. By combining the two sets of measurements on the ellipticity parameters with air and a liquid as the first medium, the film's thickness and refractive index can be evaluated independently by a self-consistency procedure. Measurements of oxide films on a silicon substrate by ellipsometer with the samples immersed in air or benzene or toluene indicate that the refractive index of the thin films in the range 80–300 Å is 1.484±0.004 for λ5461 Å. This is the first time that the refractive index and the thickness of the thin film have been independently determined. Author

N68-17298# Leiden Univ. (Netherlands).
RESEARCH ON STATISTICAL MECHANICS Final Scientific Report, Apr. 1, 1962–Oct. 30, 1967
Peter Mazur 30 Oct. 1967 9 p refs
(Grant AF-EOAR-62-99)
(AFOSR-67-2779; AD-662640)

The following research has been performed and completed: (1) Research on Brownian Motion in Systems of Finite Size; (2) Research on the Statistical-Mechanical Theory of Brownian Motion, both classical and Quantum-Mechanical; (3) Research on the Statistical-Mechanical Derivation of Maxwells Equations; (4) Research on the Relativistic Dynamics of Polarized Systems. TAB

N68-17337# Brookhaven National Lab., Upton, N. Y.
SOME EXTENSIONS OF COMPLEX METHODS FOR TWO-DIMENSIONAL FIELDS
Richard A. Beth [1967] 10 p refs Presented at the 6th Intern. Conf. on High Energy Accelerators, Cambridge, Mass., 11–15 Sep. 1967 Sponsored by AEC
(BNL-11762; CONF-670930-19) CFSTI: HC $3.00/MF $0.65

Useful extensions of complex methods for dealing with static two-dimensional fields are obtained by identifying pairs of Maxwell equations with the Cauchy–Riemann conditions for an analytic function. Author (NSA)

N68-17383# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France). Faculte des Sciences.
COLLECTIVE MOTIONS OF THE RELATIVISITIC GRAVITATIONAL GAS
Ph. Droz-Vincent and Remi Hakim Dec. 1967 26 p refs
(TH-237)

The relativistic gravitational gas is studied with the help of the linearized Einstein equations coupled to the one-particle Liouville equation. As a consequence, we derive a kinetic equation for the collective motions of a small perturbation of the gas. This equation is a linear integro-differential equation of the same kind as the Vlasov equation. Author

N68-17398# Cambridge Electron Accelerator, Mass.
RF BEAM DYNAMICS IN THE CEA STORAGE EXPERIMENT
J. Dekleva and G. L. Nicholls 17 Aug. 1967 12 p refs
(Contract AT(30-1)-2076)
(CEAL-1037) CFSTI: HC $3.00/MF $0.65

Differential equations are presented to relate the beam and the rf accelerating system of the CEA. Calculations to describe the rf parameters necessary to produce a 3-GeV beam of 100 mA are presented and discussed. NSA

N68-17426# California Univ., Livermore. Lawrence Radiation Lab.
A CHEMLA EXPERIMENT IN BeO
C. F. Cline, H. W. Newkirk, R. H. Condit, and Y. Hashimoto 6 Oct. 1967 8 p refs Presented at the Conf. on Diffusion in Oxides, Washington, D. C., 24 Oct. 1967
(Contract W-7405-ENG-48)
(UCRL-7887; CONF-671038-1) CFSTI: HC $3.00/MF $0.65

The drift of ^7Be tracer in BeO at 1550°C under the influence of an externally applied dc electric field was determined by a sectioning technique. Reasonable agreement was obtained with the Nernst–Einstein relation. Author (NSA)

N68-17509# Loughborough Univ. of Technology (England). Dept. of Mathematics.
INVESTIGATION OF STABILITY BY LIAPUNOV'S SECOND METHOD
C. Storey *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 2: Stability Probl.—Non-Linear and Transient Vibrations Jul. 1966 p 8–25 refs (See N68-17507 08-32)

Liapunov definitions of stability, Liapunov functions, and numerical constructions of these functions are considered along with other methods of stability analysis. Definitions are those of stability, asymptotic stability, instability, and practical stability; and theorems for each as well as the converse of stability theorems are given. Some applications of Liapunov functions are discussed; and Zubov's, Ingverson's, and other construction methods are considered. M.W.R.

N68-17510# Motor Industry Research Association, Lindley (England).
TRANSIENT RESPONSE OF A NON-LINEAR STEERING OSCILLATION

F. D. Hales *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 2: Stability Probl.—Non-Linear and Transient Vibrations Jul. 1966 p 26–42 ref (See N68-17507 08-32)

The transient response of an intrinsically nonlinear representation of pneumatic wheel behavior is considered using an otherwise fairly simple mathematical model. The study evolved when a steering wheel vibration accompanied by noise was observed during cornering at about 40 mph with a car fitted with smooth tires and poor dampers. Front suspension vertical degrees of freedom, steering wheel and front wheel yawing freedom, and tire forces are considered. Analog computer solutions are discussed. M.W.R.

N68-17515# Royal Aircraft Establishment, Farnborough (England).
THE STABILITY OF LINEAR DIFFERENTIAL EQUATIONS WITH PERIODIC COEFFICIENTS: AN APPLICATION OF FLOQUET'S THEOREM
D. E. Williams *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 2: Stability Probl.—Non-Linear and Transient Vibrations Jul. 1966 p 79–83 refs (See N68-17507 08-32)

Floquet's existence theorem on the form of the solution of a set of linear differential equations with periodic coefficients is used to study the stability of a tuning fork gyroscope. Author

N68-17569# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
COLLECTED WORKS OF ACADEMICIAN A. M. LYAPUNOV, VOLUME 2
A. M. Lyapunov 26 Apr. 1967 467 p refs Transl. into ENGLISH of the book "Akademik A. M. Lyapunov Sobraniye Sochineniy, Tom 2" Moscow, Izd. Akad. Nauk SSSR, 1956 p 1–473
(FTD-MT-64-209; AD-663928) CFSTI: HC $3.00/MF $0.65

The second volume contains the doctoral dissertation of A. M. Lyapunov The General Problem of Stability of Motion and all the equations connected with it after the document was published. Some corrections from a French translation of this work are included in the text. Two equations of the first order are considered. Second order equations are also included. Contributions of other scientists, Routh and Poincare are cited. The first chapter considers the integration of differential equations in question and is only introductory. In the second and third chapters, constant and periodic coefficients are considered consecutively. The second chapter touches on the questions of periodic solutions of nonlinear differential equations. Author (TAB)

N68-17632# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
MAGNETIC FIELD OF UNIFORMLY MAGNETIZED CYLINDRICAL CONFIGURATIONS [MAGNITNOE POLE RAYNOMERNO NAMAGNICHENNYKH OB'EMOV TSILINDRICHESKOI KONFIGURATSII]
V. I. Danilov and M. Ianovich 1967 34 p refs In RUSSIAN
(JINR-P9-3542)

A general method for calculating the expressions for the magnetic field components of magnetized annular cylindrical sectors, regarded as the general case of cylindrical configurations of constant height, is described. The theory is based on the assumption that the volume of the cylindrical configuration is uniformly magnetized. It is also shown that the expressions obtained for such uniformly magnetized bodies can be used for the determination of the field outside and inside a single-layer fine-wire annular sectorial solenoid. Author (NSA)

N68-17646# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).
MAGNETIC COORDINATES [COORDONNEES MAGNETIQUES]
G. Laval and R. Pellat Jul. 1967 9 p refs In FRENCH
(CERTS-01-1) CFSTI: HC $3.00/MF $0.65

The possibility to determine magnetic coordinates for a point in a stationary omnidirectional magnetic field is studied. The McIlwain model is discussed and its validity assessed. ESRO

N68-17701# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
JOURNAL OF APPLIED MECHANICS AND TECHNICAL PHYSICS, NO. 1, JANUARY–FEBRUARY 1963
14 Apr. 1967 289 p refs Transl. into ENGLISH from Zh. Prik. Mekhan. i Techn. Fiz. (Moscow), no. 1, Jan.–Feb. 1963 p 1–160
(FTD-MT-64-84; AD-663337)

A compilation of articles is presented on fluid dynamics, plasma physics, soil mechanics, thermodynamics, and shock wave propagation. For individual titles, see N68-17702 through N68-17729.

N68-17711# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PROPAGATION OF ELASTIC SURFACE WAVES IN HALF-SPACE IN A MAGNETIC FIELD [RASPROSTRANENIYE UPRUGIKH POVERKHNOSTNYKH VOLN V POLUPROSTRANSTVE, NAKHODYASHCHEMSYA V MAGNITONOM POLE]
N. I. Dolbin *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 135–140 refs (See N68-17701 08-23)

Considered here is the problem of the propagation of flat surface waves in an ideally conducting elastic half-space with flat boundary. The half-space is in a permanent magnetic field. Author

N68-17712# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MEASUREMENT OF DYNAMIC COMPRESSIBILITY OF SAND AT HIGH PRESSURES [IZMERENIYE DINAMICHESKOY SZHIMAEMOSTI NESKA PRI VYSOKIKH DAVLENIYAKH]
V. A. Lagunov and V. A. Stepanov *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 141–152 refs (See N68-17701 08-23)

This article gives certain results of measurements of dynamic compressibility of grounds at high pressures. With the help of methods developed in reference to incoherent grounds, the shock adiabat of dry sand was obtained up to stresses of 50,000 kg/cm^2. It was determined that compressibility of the sand in dynamic conditions is less than static by 10–25%. The linear dependence of shock wave propagation speed in sand on the mass velocity of sand particles over the pressure range 100 to 50,000 kg/cm^2 was established. The characteristics of ground compression at high pressures were obtained from the speed of weak shock wave propagation through extrapolation of small values; and the limiting compressibility was determined by first approximation of the relative volume of pores in a loose medium. It is shown that the reversible compressibility of sand constitutes 10–15% of its total compressibility. Author

N68-17720# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ONE LIMITING CASE OF PROPAGATION OF STRONG EXPLOSIVE WAVES IN NONUNIFORM MEDIUM
B. N. Rumyantsev *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 205–209 refs (See N68-17701 08-23)

Considered is the problem of cylindrical explosion in an inhomogeneous atmosphere close to unity. Derived is a system of equations describing the motion of gas by approximate solution for an explosion on the boundary of two media whose constant densities slightly differ from each other. Author

N68-17729# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL DEFINITION OF ELECTRICAL CONDUCTIVITY OF LIQUID SODIUM, POTASSIUM AND LITHIUM [EKSPERIMENTAL'NOYE OPREDELENIYE ELEKTROPROVODNOSTI ZHIDKIKH NATRIYA, KALIYA I LITIYA]
A. N. Solov'yev *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 267–271 refs (See N68-17701 08-23)

The magnitude of electrical conductivity must be known so as to use the fact that the ratio of electrical conductivity to thermal conduction and absolute temperature remains for practical purposes constant and to determine the thermal conduction of liquid metals more reliably than by direct measurements. Electrical conductivity is a quantity very sensitive to different impurities and structure. Therefore, experimental data can give information on structure and intermolecular forces in liquid. This article gives results of measurements on electrical conductivity of melted sodium, potassium, and lithium. Author

N68-17739*# Techtran Corp., Glen Burnie, Md.
A QUANTUM MECHANICAL THEORY OF ADSORPTION OF INERT GAS ATOMS ON A SOLID SURFACE
Motoaki Sugawara 11 p refs Transl. into ENGLISH from Kokugakkaishi (Japan), v. 13, no. 139, Aug. 1965 p 266–270
(Contract NASw-1695)
(NASA-TT-F-11493) CFSTI: HC $3.00/MF $0.65 CSCL 20J

Calculations are made on the probability of trapping an inert gas atom on a solid surface. A linear lattice is taken as a model for the solid crystal. The interaction potential between the solid surface and a gas atom is assumed to be the square well type. For every energy level of the bound state, there exists an incident energy which has the maximum probability of trapping. Author

N68-17882# California Univ., Livermore. Lawrence Radiation Lab.
TIME-RESOLVED EMISSION SPECTRA OF THE DETONATION PRODUCTS OF PETN
Edward Catalano and Howard C. Horning 16 Oct. 1967 7 p refs
(Contract W-7405-ENG-48)
(UCRL-50328) CFSTI: HC $3.00/MF $0.65

Time-resolved emission spectra were obtained from detonating pentaerythritol tetranitrate (PETN). Shuttered exposures of 200-nsec duration were taken with a Kerr cell, at times from 0.1 to 3.5 μsec after the detonation front had passed. Several emission lines were obtained, superposed on a very low intensity continuum. Attempts were made to estimate the emissivity of the continuum. Author (NSA)

N68-17947*# Massachusetts Inst. of Tech., Cambridge. Center for Space Research.
INTERFACIAL RELAXATION OVERSTABILITY IN A TANGENTIAL ELECTRIC FIELD
James R. Melcher and W. J. Schwarz, Jr. Jan. 1968 29 p refs
(Grant NsG-368)
(NASA-CR-93332; CSR-TR-68-2) CFSTI: HC $3.00/MF $0.65 CSCL 20C

Electromechanical polarization surface waves have a stiffening effect on electrohydrodynamic equilibria that is analogous to that of the Alfvén surface waves on hydromagnetic equilibria. An investigation is presented of the dynamical effects of charge relaxation of these waves. A self-consistent model represents the relaxation in terms of an Ohmic conduction process in the bulk of the fluids, with surface shears induced by the free interfacial charges placed in dynamic equilibrium by viscous stresses. The dominant effect of the charge relaxation is to produce overstability. Experiments are described where this instability appears as a spontaneous oscillation of the interface with wavenumbers directed along the lines of electric field intensity. Detailed analytical results are given for liquid-gas and liquid–liquid interfaces. It is found that in this liquid-vapor case, relatively simple explicit expressions can be given for the incipient instability conditions. A discussion is given of the significance of this work for the dielectrophoretic orientation of liquids in the zero-gravity environments of space. Author

N68-17959# Tennessee Univ., Knoxville. Ultrasonics Lab.
A STUDY OF THE ULTRASONIC SPECTRUM IN A RESONANT CAVITY
Ching-tu Chang and M. A. Breazeale Jul. 1967 72 p refs
(Contract Nonr-4289(01))
(TR-3; AD-663908)

A spectrum analyzer is used to examine the ultrasonic spectra produced when large amplitude ultrasonic waves are caused to resonate in a water-filled cavity. The cavity, consisting of a plane transducer and concave reflector, produces frequency components which appear to be the result of beating (a linear process) and/or modulation (a non-linear process). A scheme for labelling the frequency components is developed. Author (TAB)

N68-18035*# Stanford Univ., Calif. Microwave Lab.
INVESTIGATION OF LASER DYNAMICS, MODULATION AND CONTROL BY MEANS OF INTRA-CAVITY TIME VARYING PERTURBATION Semiannual Status Report, 1 Aug. 1967–1 Feb. 1968
S. E. Harris 1 Feb. 1968 29 p
(Grant NGR-05-020-103)
(NASA-CR-93363; Rept.-1617; SASR-4) CFSTI: HC $3.00/MF $0.65 CSCL 20F

Research is being conducted on the generation, control, and stabilization of optical frequency radiation, and in particular, is concerned with attaining tunable optical sources by means of nonlinear optical techniques. Efforts this period were concerned with optical parametric fluorescence, fluorescence and superradiance in $LiNbO_3$ pumped at 0.694 u, parametric oscillation at optical frequencies, and backward wave oscillation in the far infrared. R.N.A.

N68-18108*# Rocketdyne, Canoga Park, Calif.
THE DOPPLER ANALOG OF AN ELSASSER BAND MODEL
S. A. Golden *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 436–438 refs (See N68-18082 08-33)

Abstracted data are presented on the properties of the spectral absorption coefficient and integrated emissivity (the equivalent width) of the Doppler analog of an Elsasser band model. Author

N68-18198*# Hughes Research Labs., Malibu, Calif.
MEASUREMENT OF SPUTTERING YIELDS AND ENERGY TRANSFER EFFICIENCIES OF LIQUID METALS Final Report
H. L. Garvin Jan. 1968 95 p refs
(Contract NAS3-6273)
(NASA-CR-54678) CFSTI: HC $3.00/MF $0.65 CSCL 21C

In order to determine the difference in the sputtering of metals in their liquid and solid states, and to employ this difference, if any, in extending the electrode life of electrostatic ion thrustors, the sputtering yield and energy transfer efficiency of ion bombarded, liquid aluminum, gallium, indium, cerium, lead, and tin were investigated in the temperature range of 600° to 1000°C. The results indicate that for the conditions of normal incident ions, as would be the case on the flat surfaces of thrustor electrodes, no large increase or decrease in sputtering yield results from the change in state. Thus, the employment of liquid metal electrodes in ion thrustors does not warrant the mechanical complications which would be required. The experimental results are of academic

interest though, in establishing theoretical models for sputtering of materials in both their solid and liquid state. The vacuum system and instrumentation used in the experiment are described in detail. E.J.S.

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N68-17221# Deutsches Elektronen-Synchrotron, Hamburg (West Germany).

THE EFFECT OF TARGET THICKNESS AND COLLIMATION ANGLE ON THE BREMSSTRAHLUNG BEAM IN THE GeV REGION [DER EINFLUSS VON TARGETDICKE UND KOLLIMATION AUF DAS BREMSSPEKTRUM IM GeV-BEREICH]

G. Lutz and H. D. Schultz. Sep. 1967. 34 p. refs. In GERMAN; ENGLISH summary.
(DESY-67/29)

A calculation of the effects of target thickness and collimation angle on the intensity and the spectral distribution of a bremsstrahlung beam is presented. The beam is assumed to have been produced by electrons with energies in the region 1 to 6 GeV. The results are compiled in tables, permitting interpolation for other arrangements. Author (NSA)

N68-17222# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.

ABSOLUTE NUCLEAR ACTIVITY MEASUREMENTS USING THE γ-γ COINCIDENCE METHOD [MESURES ABSOLUES D'ACTIVITE NUCLEAIRE PAR LA METHODE DES COINCIDENCES γ-γ]

Paulette Benoit and Claude Philis. Jun. 1967. 54 p. refs. In FRENCH.
(CEA-R-3260)

A summary is first given of the principle of the γ–γ calibration method, with emphasis on the corrections required. After a description of the equipment used, the choice of the experimental conditions required for various isotopes (^{22}Na, ^{46}Sc, ^{60}Co, ^{88}Y) is discussed, and the agreement between these results and those obtained by other absolute measurement methods is considered. Author (NSA)

N68-17238*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

POSSIBLE RESONANCE IN POSITRON HYDROGEN SCATTERING

Richard J. Drachman. Jan. 1968. 19 p. refs.
(NASA-TM-X-63113; X-641-68-58) CFSTI: HC $3.00/MF $0.65
CSCL 20H

The positron–hydrogen system is considered, with the view to determining whether a scattering resonance below the positronium threshold is likely to occur, as has been suggested by Bransden and Jundi. The likeliest mechanism for producing such a resonance would be the existence of a virtual bound state in the positronium–proton channel, brought about by the large dipole polarizability and mass of the positronium atom. A modification of Holoien's technique enables one to reject spurious solutions without the use of the projection operator technique. A non-vairational adiabatic calculation seems to indicate that a resonance does exist, lying at 0.1 eV below the threshold. When, however, a variational treatment is employed, certain essential non-adiabatic terms appear. The resultant reduction in attraction serves to eliminate the apparent resonance. It is concluded that the previously reported resonance is probably an artifact. Author

N68-17256# Stanford Univ., Calif. Stanford Linear Accelerator Center.

A FIRST AND SECOND ORDER MATRIX THEORY FOR THE DESIGN OF BEAM TRANSPORT SYSTEMS AND CHARGED PARTICLE SPECTROMETERS

Karl L. Brown. Jul. 1967. 109 p. refs.
(Contract AT(04-3)-515)
(SLAC-75) CFSTI: HC $3.00/MF $0.65

A matrix algebra formalism is used to develop the essential principles governing the design of charged particles beam transport systems, with a particular emphasis on the design of high-energy magnetic spectrometers. NSA

N68-17256# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.

HETEROGENEITY CALCULATIONS INCLUDING SPACE DEPENDENT RESONANCE SELF SHIELDING

D. Wintzer. Oct. 1967. 23 p. refs. Presented at the IAEA Symp. on Fast Reactor Phys. and Related Safety Probl., Karlsruhe, Germany, 30 Oct.–3 Nov. 1967.
(EURFNR-402; EUR-3677.E; KFK-633; CONF-671043-11) CFSTI: HC $3.00/MF $0.65

A method to determine heterogeneity effects on the reactivity is described for a lattice cell containing material of large resonance cross sections that takes into account space dependent self shielding in a multiregion lattice cell. The method is based on a multigroup collision probability formalism of reaction rates and neutron emission densities in the cell regions and is applied in a computer program called ZERA. This method can be applied to thermal reactor problems. Several results of ZERA calculations for rod lattices and for plane lattices are presented and compared with experimental results. NSA

N68-17277# Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.

ENERGY AND ANGULAR DEPENDENCE OF AIR SCATTERED GAMMA RAY DISTRIBUTION FUNCTIONS

J. A. Michael and H. A. Lamonds. [1967] 23 p. refs. Presented at the 15th Am. Nucl. Soc. Conf. on Remote Systems, Technol. and Atom Fair, Chicago, 9 Nov. 1967. Sponsored by AEC
(Contract AT(29-1)-1183)
(EGG-1183-2163; CONF-671102-38) CFSTI: HC $3.00/MF $0.65

Both energy and number distribution functions were calculated for 15 source energies in the range 100 keV to 3 MeV for eight penetration distances spanning the range from 3 to 1,000 ft. The angular dependences of all these distribution functions were calculated, as well as number and exposure buildup factors. The calculational technique is reviewed, leading into a discussion of the convergence properties of the calculation. Results obtained for a ^{137}Cs source are presented as a sample of the entire set. This calculation and other calculations made by both the method of moments and Monte Carlo techniques are compared. NSA

N68-17302# Brookhaven National Lab., Upton, N. Y. Physics Dept.

HYPERFINE STRUCTURE IN A FLUCTUATING ENVIRONMENT

M. Blume. [1967] 32 p. refs. Presented at the Intern. Conf. on Hyperfine Interactions Detected by Nucl. Radiation, Pacific Grove, Calif., Aug. 1967. Sponsored by AEC
(BNL-11884; CONF-670812-16) CFSTI: HC $3.00/MF $0.65

The theory of hyperfine structure in the presence of time-dependent electronic fluctuations (such as those induced by electron spin relaxation) is considered. A general expression applicable to the Moessbauer line shape, perturbed angular correlations, angular correlation NMR, and resonance in oriented nuclei is derived. A number of realistic, exactly soluble stochastic models for relaxation phenomena are presented and are compared with perturbation–theoretic treatments such as those of Abragam and

Pound and Bradford and Marshall. The theory is applied to the calculation of the Moessbauer line shape and also to the calculation of angular correlations of successive nuclear decays. Author (NSA)

N68-17327# Maryland Univ., College Park. Dept. of Physics and Astronomy.
UNIVERSAL COUPLING OF THE OMEGA MESON AND REGGE RESIDUES
M. K. Banerjee and C. A. Levinson Jun. 1967 16 p refs
(Contract AT(40-1)-3491)
(TID-24135) CFSTI: HC $3.00/MF $0.65

Some of the experimental data in favor of the experimental hypothesis of universality of omega coupling is considered. The low energy data on the coupling of omega meson and the high-energy data on the coupling of omega-type Regge trajectory were considered. The data seem to support the universality hypothesis. The universal omega coupling constant $g_\omega^2/4\pi$ is estimated to be 1.24 ± 0.31, which is higher than the universal rho coupling constant $g_\rho^2/4\pi = 0.65\pm0.17$. To relate the Regge residues of vector trajectories to the universal coupling constant the angular momentum dependence of the former is factored out, and "reduced" Regge residue and a scale parameter for each trajectory are introduced. The scale parameters for the omega and the rho trajectories turn out to be remarkably cose to one another and are of the order of 260 and 290 MeV, respectively. Author (NSA)

N68-17347# General Electric Co., Philadelphia, Pa. Missile and Space Div.
ELECTRONIC ENERGIES AND WAVEFUNCTIONS FOR OCTAHEDRAL POLYATOMIC MOLECULES
Robert O. Platz Jan. 1968 57 p refs
(Contract ARPA SD-102)
(R68SD3)

This report documents the method and approximations of a highly refined computer program for determining Hartree–Fock molecular wave functions and electronic energies for octahedrally-symmetric molecules of the monatomic $[(FeF_6)^{-4}, SF_6]$ and diatomic $[Fe(CN)_6^{-4}, Cr(CO)_6]$ ligand variety, which conform to the O_h point group. Ground and excited states of both neutral and ionic species in closed and open shell configurations are considered. Author

N68-17389# California Univ., Livermore. Lawrence Radiation Lab.
CASCADE EXCITATION OF THE HYDROGEN ATOM BY PASSAGE THROUGH A PLASMA TARGET [KASKADNOYE VOZBUZHDENIYE ATOMA VODORODA PRI PROKHOZHDENII CHEREZ PLAZMENNUYU MISHEN]
D. P. Grechukin and E. I. Karpushkina Oct. 1967 79 p refs Transl. into ENGLISH from the Russian Report IAE-1364
(UCRL-TRANS-10138; IAE-1364) CFSTI: HC $3.00/MF $0.65

An analysis is presented of the cascade excitation of the hydrogen atom by passage through a plasma for the following cases: (a) the plasma is in a magnetic field, which produces ionization of highly excited states; and (b) there is no magnetic field in the plasma. The objects are to elucidate the main features of cascade excitation and the possibility of using this excitation mechanism in the injection of neutral atoms into a magnetic trap. The rapid-flight method is used to estimate the cross sections for ionization of highly excited hydrogen atoms by the fields of atoms and ions, and also of electric dipoles and quadrupoles. Author (NSA)

N68-17393# Oklahoma State Univ. Research Foundation Stillwater. Dept. of Physics.
QUANTUM FIELD THEORY
R. Rodenberg, J. Cantril, B. P. Clark, L. Peery, G. Tunheim et al May 1967 240 p refs Presented at Seminar held at Okla. State Univ., 1966
(NP-17143)

The discussion of quantum field theory covers the Lagrange formalism and conservation laws (Noether theorem), field equation of the free fields (noncovariant commutation relation), field equations of an interacting field, the meaning of field quantization, second quantization for the Schroedinger field, equivalence to the many body problem, and construction of the Hilbert space, and the Schroedinger and Heisenberg interactions. Also covered are quantizations of the Klein–Gordon field, (the Δ function), the Dirac field (the S function), and the electromagnetic field (the D function), the S-matrix perturbation theoretical expansion, reduction of the S-matrix, Feynman diagrams, vacuum amplitudes (Furry theorem) and the S-matrix theory representation in the momentum space. NSA

N68-17394# Case Western Reserve Univ., Cleveland, Ohio.
HIGH-ENERGY MACHINE PHYSICS Technical Report, 1 Oct. 1966–30 Sep. 1967
F. Reines and T. L. Jenkins Jun. 1967 6 p refs
(Contract AT(11-1)-818)
(COO-818-103) CFSTI: HC $3.00/MF $0.65

Current high-energy physics research at Case Institute of Technology is very briefly discussed. Included topics are D_2O solar neutrino experiment and baryon stability experiment, double beta decay apparatus, high-energy physics at accelerators, and the flying spot scanner. NSA

N68-17400# Argonne National Lab., Ill.
FAST-NEUTRON SCATTERING FROM TANTALUM, RHENIUM, AND PLATINUM
A. B. Smith, P. T. Guenther, R. Hayes, and J. F. Whalen Aug. 1967 54 p refs
(Contract W-31-109-ENG-38)
(ANL-7363) CFSTI: HC $3.00/MF $0.65

The scattering of neutrons with energies $\leq$1.5 MeV from tantalum, rhenium, and platinum was studied experimentally. Elastic and inelastic neutron scattering angular distributions were determined at incident neutron-energy intervals of $\leq$20 keV throughout the range 0.3 to 1.5 MeV. Time-of-flight measurements were made concurrently at eight or more scattering angles between 25 and 155° with sufficient scattered neutron energy resolution to separate the elastic scattered component from most inelastic scattered neutron groups. Differential inelastic scattering cross sections were observed. The experimental results were compared with calculations based upon the optical model and the Hauser–Feshbach formula inclusive of corrections for resonance-width fluctuations. The experimentally observed level structure is discussed in the context of single-particle and rotational states of deformed nuclei. Author (NSA)

N68-17409*# College of William and Mary, Williamsburg, Va.
ENERGY AND WIDTH MEASUREMENTS OF LOW-Z PIONIC X-RAY TRANSITIONS
R. J. Harris, Jr., W. B. Shuler, M. Eckhause, R. T. Siegel, and R. E. Welsh [1967] 11 p refs
(Grant NsG-567)
(NASA-CR-93190; WM-11) CFSTI: HC $3.00/MF $0.65 CSCL 20H

New measurements have been performed of the energies and natural line widths of 2p-1s pionic X-ray transitions, as well as muonic transition energies, in Li^6, Li^7, Be^9, B^{10}, B^{11}, and C^{12}. High-resolution Si(Li) and Ge(Li) spectrometers were used, resulting in a more precise determination than previously reported of the transition energies and natural line widths. Comparison of the measured complex energy shifts in the pionic transitions has been made with the theory of the Ericsons and good agreement found. Author

N68-17437# Los Alamos Scientific Lab., N. Mex.
NONDESTRUCTIVE DETECTION, IDENTIFICATION, AND ANALYSIS OF FISSIONABLE MATERIALS

G. Robert Keepin 20 Nov. 1967 17 p refs
(Contract W-7405-ENG-36)
(LA-3741) CFSTI: HC $3.00/MF $0.65

Characteristic differences in relative group yields and energy spectra of delayed neutrons from the various fission species are used to provide unique methods for nondestructive detection, identification, and analysis of unknown mixtures of fissionable materials. Basically, these methods consist of detailed analysis (in time and, as a further refinement, in energy) of the measured delayed neutron activity from an unknown system following fast neutron irradiation. It is shown that such delayed neutron kinetic response measurements are largely free of the interfering and distorting effects inherent in other methods of detection and analysis. Besides practical applications to isotope identification and quantitative analysis in mixed systems, the methods are shown to be especially sensitive to fissile versus fertile ($k_\infty < 1$) fissionable materials—a distinction of practical importance in nuclear safeguards inspection and surveillance techniques. Full exploitation of the outlined methods promises a wide range of applications in the nuclear industry as well as in the emerging field of national and international nuclear safeguards and atomic energy control.
Author (NSA)

N68-17538# Joint Publications Research Service, Washington, D. C.
ASYMPTOTIC P_N APPROXIMATION
V. S. Shulepin *In its* Soviet Atomic Energy Res. 15 Feb. 1968 p 28-31 refs (See N68-17535 08-22)

A simplified method is proposed for solving the transport equation for neutrons in the P_N-approximation, and for calculating both components for large N. This is based on rejecting the condition of continuity of the scalar flux at the boundary of the media, and using only the asymptotic component with effective conditions at this boundary.
Author

N68-17539# Joint Publications Research Service, Washington, D. C.
FORMATION OF Pu^{238} BY NEUTRON IRRADIATION OF U^{235} AND Np^{237}
In its Soviet Atomic Energy Res. 15 Feb. 1968 p 32-40 refs (See N68-17535 08-22)

To find the optimal conditions of irradiation to ensure the largest accumulation of Pu^{238}, calculations on the formation of Pu^{238} were carried out for different neutron fluxes (10^{13}, 10^{14}, 10^{15}, and 10^{16} neutrons/cm^2/sec). The data used on the half-lives and reaction cross sections of slow neutrons with the nuclei are tabulated. Results of calculating the formation of Pu^{238} from U^{235} are given in terms of the amount of remaining U^{235} isotope as a function of irradiation time and the accumulating amount of nuclei of Pu^{238}, referred to the initial number of U^{235} nuclei. The data show that the maximum accumulation of Pu^{238} is 0.2% with regard to the initial amount of U^{235}, with almost total burn-up of the latter. With increased neutron flux, the yield of Pu^{238} in the region of optimal times of irradiation decreases. Similar calculations on the formation of Pu^{238} from Np^{237} are also given. In contrast to the irradiation of U^{235}, the final products contain a significant amount of the starting isotope Np^{237} which can be recovered.
M.G.J.

N68-17573# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
CROSSING RELATIONS FOR HELICITY AMPLITUDES IN PROCESSES WITH N FINAL PARTICLES AND THEIR IMPLICATIONS FOR THE MULTI-REGGE MODEL
A. Capella Jan. 1968 31 p refs
(TH/235)

The crossing relations for helicity amplitudes are generalized to processes with n particles in the final state; these relations are obtained under the assumption that the spinor amplitudes are analytic in a domain big enough to allow crossing. The crossing relations turn out to be very similar to those for two-body processes. The consequences of the crossing relations for the multi-Regge model are analyzed, mainly in connection with the factorization principle. Applications are made to the study of decay angular distributions of resonances produced in such processes.
Author

N68-17617# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
SOBER, A MONTE CARLO PROGRAM FOR NEUTRON AND GAMMA RAY TRANSPORT IN COMPLEX GEOMETRIES
T. M. Jordan May 1967 143 p refs
(DAC-60659) CFSTI: HC $3.00/MF $0.65

Unique analytical methods and numerical techniques were developed for Monte Carlo solution of the stationary energy-dependent Boltzman equation. Analytical methods include: (1) the use of energy-independent biasing functions in the random selection of position and direction vectors; (2) the use of energy-dependent packets, with each packet respresenting a multitude of the mono-energetic particles; (3) analytic integration of the energy-dependence of the integral equation for scattered source densities; and (4) a technique for estimating optimum values of adjustable parameters in the biasing functions, based on partial derivatives of the coefficient of variation. Numerical techniques include: a simplified procedure for describing the independent source; treatment of quadric surface geometries; the use of multigroup constants for neutron transport calculations coupled with an exact treatment of the angular dependence of scattering by hydrogen; the use of the exact Klein–Nishina equation for gamma ray scattering by free electrons; the generation of Legendre coefficients describing angular fluxes; and analytic estimation of angular flux moments for volume, quadric surface, and point detectors.
Author

N68-17618*# College of William and Mary, Williamsburg, Va. Physics Dept.
MEASUREMENTS OF 2P-1S LINE WIDTHS IN LOW-Z PIONIC ATOMS
Robert J. Harris, Jr. (Ph.D. Thesis) Jan. 1968 139 p refs
(Grant NsG-567)
(NASA-CR-93178) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The natural line widths of 2p-1s transitions in low-Z pionic atoms were measured using high-resolution lithium-drifted silicon [Si(Li)] and germanium [Ge(Li)] detectors. High resolution was achieved by developing a low-noise cooled FET preamplifier which allowed the inherently good resolving capability of Si(Li) and Ge(Li) detectors to be more fully exploited than was previously possible. The instrumental resolution as measured with muonic X-rays with 0.62 keV (FWHM) at 33 keV for the Si(Li) spectrometer, and 1.1 keV (FWHM) at 75 keV for the Ge(Li) spectrometer. Pionic atoms were formed by stopping negative pions in the following targets: Li^6, Li^7, Be^9, B^{10}, B^{11}, and C^{12}. The results obtained for pionic 2p-1s natural line widths are given. Theoretical values for the natural line widths were computed from the theory of Ericson and Ericson and found to be in good agreement with the above measured results.
Author

N68-17622*# Pittsburgh Univ., Pa. Space Research Coordination Center.
POLARIZATION OF LYMAN ALPHA RADIATION EMITTED BY H(2S) ATOMS IN WEAK ELECTRIC FIELDS
W. L. Fite, W. E. Kauppila, and W. R. Ott 21 Feb. 1968 6 p refs Sponsored by NSF
(Grant NsG-416)
(NASA-CR-93254; SRCC-70) CFSTI: HC $3.00/MF $0.65 CSCL 20H

In order to verify a zero polarization prediction, a modulated beam of ground-state hydrogen atoms was crossed by a dc electron beam, and metastable H(2S) atoms were produced by electron-impact excitation. The Lyman alpha radiation produced by the electric quenching of the metastable atoms was detected at 90° with respect to the quench field direction and its polarization was examined. Contrary to previous data, it was found that the

polarization was not zero, and the intensity of the component with the electric field vector parallel to the direction of the quench field was weaker than the intensity of the opposite polarization. Errors in previous data are pointed out and through elementary calculation a polarization of −32.9% is predicted. B.S.D.

N68-17623# Tokyo Univ. (Japan). Physics Dept.
MASSES OF BOSONS WITH HIGHER SPINS AND THE SPECTRAL FUNCTION SUM RULES
Syurei Iwao 17 Jan. 1968 5 p refs

The spectral representation of boson fields carrying spin greater than 2 is considered, and the mass eigenvalues predicted by this theory are compared with the semi-empirical relation based on the theory of complex angular momentum. It is assumed that the Regge recurrence goes to the infinite or sufficiently high value of spin for each trajectory carrying definite internal and signature quantum numbers, and the exact symmetry at infinite momentum is conjectured. All the higher spin values are described by the symmetric tensor fields, and the generalized relationship in which the divergence of the tensor fields is proportional to one lower tensor field with an opposite parity. A relationship is given for the vacuum expectation value of the product of the symmetric tensor current, and the Fourier transforms of the vacuum expectation value are defined. The associated meson dominance hypothesis leads to the sum rules between the coupling constants as well as the those for the masses. A mathematical representation of the Regge recurrence for mesons with the definite signature is also given. B.S.D.

N68-17645# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics.
STUDIES OF γ EMISSION FROM $^{12}C(^3HE,P\gamma)^{14}N$ REACTION [ISSLEDOVANIE γ IZLUCHENIYA IZ REAKTSII $^{12}C(^3HE,P\gamma)^{14}N$]
Yu. D. Mareev, G. M. Osetinskii, B. Savitska, I. V. Sizov, and Yu. S. Yazvitskii 1967 15 p refs In RUSSIAN
(JINR-P6-3463)

Using an electrostatic generator, the γ emission from the reaction $^{12}C(^3He,p\gamma)^{14}N$ was investigated. By use of the Doppler broadening of the spectral peaks, the upper limits of the life-times of the six observed levels of ^{14}N were determined to be $\leq 5\times10^{-13}$ sec. On the basis of the angular distribution of the γ quanta, the spins for some excited states of the nuclei ^{15}O and ^{14}N were evaluated. Author (NSA)

N68-17662# Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu.
DEUTERON STRIPPING AND PICK UP REACTIONS
V. Kroha and S. Piskor Aug. 1967 88 p refs
(UJV-1870)

The dynamics of the (d,p) reaction is discussed with primary consideration of the reliability of the theory of this reaction. The shape and magnitude of the effective differential cross section of the reaction are studied; comparisons are made with experimental data. Spectroscopic applications of direct reactions are then discussed from the viewpoint of different models for nuclear structure. NSA

N68-17666*# Union Carbide Corp., White Plains, N. Y. Space Sciences and Engineering Lab.
CROSS SECTION CALCULATIONS AND THE STUDY OF SPACE VEHICLE RADIATION SHIELDING Final Report
Clayton D. Zerby and Henry Brysk 15 May 1967 109 p refs
(Contract NAS8-18007)
(NASA-CR-61573; UCC/DSSD-270) CFSTI: HC $3.00/MF $0.65 CSCL 18F

Calculations from theoretical analysis and computer programming are presented for Bremsstrahlung cross sections formulated with Dirac wave functions for screened and unscreened nuclear electrostatic fields. Since the screened potential is obtained from self-consistent field calculations and requires the wave functions to be expanded in a series of angular momentum states, the formulation is suitable only at relatively low incident energies. With a simple input modification, the program is equally applicable to the calculation of Bremsstrahlung from positrons and positive and negative muons. Presented are the eigenfunctions of the energy and angular momentum operator to the Dirac equation, the computation of matrix elements, and the analytic limit of the Coulomb wave functions as the kinetic energy goes to zero. Initial values and equations for the radial integrals are covered, phase shift determination by wave-matching at the cut-off radius is described, and procedures are given for the computation of normalization factors. The structure of the computer program is outlined, operational instructions are included, and a comparison of computer results with experiment is presented. M.W.R.

N68-17699# Tokyo Univ. (Japan). Inst. of Physics.
ON THE FORM FACTORS OF RADIATIVE DECAYS OF CHARGED KAONS
Hiroshi Namaizawa 22 Dec. 1967 8 p refs
CFSTI: HC $3.00/MF $0.65

An analogous zero energy theorem is given for the structure dependent axial-vector photon emissions factor for radiative decay of charged kaons. The soft-K technique and chiral $SU_3\times SU_3$ current algebra are used in conjunction with references to the conservation of electromagnetic current and the generalized PCAC relation for strangeness carrying axial-vector currents. Photon energy spectra are calculated. M.W.R.

N68-17731*# Nuclear Utility Services, Inc., Washington, D. C.
CODE CUBED 2: A CODE TO UNFOLD BREMSSTRAHLUNG EXPERIMENTAL DISTRIBUTIONS
J. J. Steyn Sep. 1967 225 p refs
(Contract NAS5-10337)
(NASA-CR-93210; NUS-395) CFSTI: HC $3.00/MF $0.65 CSCL 20H

A Fortran 4 code for the IBM-7094 computer has been developed to analyze multi-channel pulse-height analyzer gamma photon spectral distributions. The distributions for which the code was developed are those encountered in the measurement of the bremsstrahlung radiation field from volume beta sources, which may consist of a limited number of line spectra in association with the bremsstrahlung. The code generates the detector system response matrix function and applies it to the monoenergetic spectral components discretely and to the bremsstrahlung iteratively. It corrects for iodine K X-ray escape, detector non-linearity, system drift, source decay, background, and detection efficiency. The code presents digital results in the form of differential and integrated photon number and energy distributions, and exposure dose. The code optionally outputs spectral data for use as input to a Calcomp plotting program. Author

N68-17733# Air Force Systems Command, Kirtland AFB, N. Mex. Air Force Weapons Lab.
COMPTON SCATTERING BY BOUND ELECTRONS Technical Report, Jul. 1966–May 1967
Larry V. East and Edwin R. Lewis (M.S. Thesis) Dec. 1967 51 p refs
(AFWL-TR-67-120; AD-663424)

The deviation in the Compton effect due to the finite binding energy of the atomic electrons was experimentally determined for K-shell electrons of tantalum, gold, and uranium. The differential cross section for scattering of 662 keV photons by K-shell electrons was obtained by measurements of the scattered photons in coincidence with the accompanying K X-ray and compared with the Klein-Nishina cross section for scattering by free electrons. The behavior of the ratio of the two cross section ratios was determined for scattering angles varying from 20 degrees to 70 degrees. The results indicate that the cross section ratio approaches zero as the photon scattering angle decreases to zero, and becomes >1 for

scattering angles greater than 40 degrees for Ta and 50 degrees for Au. Author (TAB)

N68-17784# Los Alamos Scientific Lab., N. Mex.
CROSS SECTIONS FOR ELECTRON EXCITATION OF THE 3914 Å (0,0) BAND OF THE MOLECULAR NITROGEN ION FIRST NEGATIVE SYSTEM
Redus F. Holland 29 Dec. 1967 15 p
(Contract W-7405-ENG-36; ARPA Order 631)
(LA-3783; AD-663571) CFSTI: HC $3.00/MF $0.65

As part of a study of the emission from nitrogen excited by an electron beam, cross sections for electron excitation of the 3914-A (0,0) band of the N2(+) first negative system were measured for electron energies of 95 to 2023 eV. Because published values for these cross sections differ by factors of two to three, an effort was made to establish the accuracy of the measurements. 3914-A band intensity was measured with two independently calibrated photometers and a scanning spectrometer. A comparison of equipment and joint observations were made with experimenters from two other laboratories. The cross section obtained for the 3914-A band at 95 eV is 1.5 x 10 to the -17th power sq cm, and that at 2023 eV is 3.1 x 10 to the -16th power sq cm. By a simple calculation, one can derive a corresponding efficiency of 0.0043 for the production of the 3914-A band by electrons in air. The excitation cross sections are in reasonable agreement with other recent measurements, but are higher than some values reported earlier. The calculated efficiency is in fair agreement with the results of laboratory efficiency measurements. Author (TAB)

N68-17864# Princeton Univ., N. J. Dept. of Physics.
MEASUREMENT OF THE NEUTRAL K-1—NEUTRAL K-2 MASS DIFFERENCE Technical Report, Jun. 1965–Oct. 1967
Robert K. Carnegie (Ph.D. Thesis) 9 Oct. 1967 95 p refs
(Contract N0014-67-A-0151-001)
(TR-44; AD-663759)

A new measurement of the magnitude of the neutral-K-1 - neutral-K-2 mass difference was completed using the gap method. The virtue of this method, which consists of monitoring the coherently regenerated neutral-K-1 intensity behind two slabs of material separated by a variable air gap, is its relative freedom from possible systematic errors. The result for the mass difference does not depend on precise knowledge of either the nuclear regeneration amplitude or the details of the detection efficiency of the apparatus. Author (TAB)

N68-17883# Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
SPECTRAL FUNCTION SUM RULES AND MASSLESS MESONS
F. Capra Jan. 1968 6 p refs
(TH/232)

Using the asymptotic symmetry approach of Das, Mathur and Okubo, we show that Weinberg's second spectral function sum rule and its generalization to $SU_3 \otimes SU_3$ can be derived in a consistent way only in the limit of massless spin zero mesons. This limit has to be kept in all applications of the sum rule, in particular in the calculation of the pion mass difference. Author

N68-17894# European Atomic Energy Community, Brussels (Belgium).
RELATIVISTIC CALCULATIONS OF KINEMATIC PARAMETERS FOR NUCLEAR REACTIONS
H. Horstmann and H. Liskien Jan. 1968 32 p refs
(EUR-3668.E) CFSTI: HC $3.00/MF $0.65

A FORTRAN program for relativistic calculations of general kinematic parameters for nuclear reactions is described. The usefulness of the program is demonstrated by means of calculations for neutron-producing reactions. Author

N68-17898*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
EXPERIMENTAL STUDY OF TRANSMISSION AND BACKSCATTER OF 0.075 TO 1.0 MeV ELECTRONS BY ALUMINUM AND STAINLESS STEEL
William E. Miller and Herbert D. Hendricks Washington Mar. 1968 22 p refs
(NASA-TN-D-4363) CFSTI: HC $3.00/MF $0.65 CSCL 18F

An experimental study of the transmission and backscatter coefficients for aluminum and stainless steel irradiated with 75-keV to 1-MeV electrons at normal and 45° incidence is reported. The transmission coefficients were greater and the backscatter coefficients were smaller at normal beam incidence than they were at 45° beam incidence for both materials. In all cases the aluminum had higher transmission coefficients and lower backscatter coefficients than did stainless steel. It was determined that the transmission and backscatter coefficients for both aluminum and stainless steel were independent of the number of layers of foils used to attain a given thickness. The ratio of the thickness for maximum backscatter to the extrapolated range was found to be nearly a constant for each material. Transmission curves independent of energy were constructed for aluminum and stainless steel for normal and 45° beam incidence. Author

N68-17907# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DOSIMETRY OF IONIZING RADIATIONS
V. I. Ivanov 12 Apr. 1967 264 p refs Transl. into ENGLISH from the book "Dozimetriya Ioniziruyushchikh Izlucheniy" Moscow, Atomizdat, 1964 p 1–263
(FTD-MT-65-160; AD-663930)

The training aid is written on the basis of a course of lectures read by the author at the Moscow Engineering-Physics Institute, and is designed for a reader familiar with atomic and nuclear physics, methods of registration of radiation, and interaction of radiation with substance. The book sets forth physical bases, calculation and experimental methods of dosimetry in conformity with effective training programs. The aid is intended for students specializing in the area of physics of shielding and dosimetry. The book will be useful to engineers, technicians, and laboratory assistants, practically studying questions of the dosimetry of nuclear radiations. Author (TAB)

N68-17938# Michigan Univ., Ann Arbor. Radiation Lab.
INVERSE SCATTERING INVESTIGATION Quarterly Report, 3 Apr.–3 Jul. 1967
Vaughan H. Weston and John H. La Rue Bedford, Mass. Electron. Systems Div. Jul. 1967 32 p refs
(Contract F19628-67-C-0190)
(Rept.-8579-2-Q; ESD-TR-67-517, V. 2; QR-2; AD-663450)

The problem in question consists of determining means of solving the inverse scattering problem where the transmitted field is given and the received fields are measured, and this data is used to discover the nature of the target. The problem of what information can be determined about the body if the scattering matrix (phase and amplitude) is known only over an angular sector and measured in the far field, is studied further. Asymptotic analysis is used to show that in the high frequency case, portions of a piecewise smooth, convex surface can be found when knowledge of the bistatic scattered field is confined to a small cone. Author (TAB)

N68-17986# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THEORY OF NUCLEAR MAGNETIC RESONANCE
I. V. Aleksnadrov 7 Apr. 1967 193 p refs Transl. into ENGLISH from the book "Teoriya Yadernogo Magnitnogo Rezonansa" Moscow, Izd. Nauka, 1964 p 1–208
(FTD-MT-65-429; AD-663931)

The monograph is an attempt to expound certain basic contemorary concepts on the theory of nuclear magnetic resonance (NMR) (RMP). The literature list contains a number of books and also survey articles devoted to NMR. However, in all these works basic attention is given to graphic physical interpretation of phenomenon and to experimental problems of this method and its applications. Theoretical questions of NMR in available books and survey articles receive comparatively little space. In the monograph the authors ignore entirely questions connected with experimental techniques in NMR, referring the reader to cited works. Chapters I and II are devoted to theory of nuclear paramagnetic relaxation; Chapter III - questions of form of line in solid bodies; Chapter IV - theoretical questions of magnetic spectroscopy (chemical shift and spin-spin interaction in molecules); in Chapter V are considered certain questions connected with Bloch phenomenological equations. Author (TAB)

N68-18013# Rochester Univ., N. Y. Dept. of Physics and Astronomy.

ANTIHYPERON, HYPERON AND TWO-BODY REACTIONS IN 13 GeV/c K^+ p COLLISIONS

J. C. Berlinghieri, M. S. Farber, T. Ferbel, B. Forman, A. C. Melissinos et al. 14 Sep. 1967 21 p refs

(Contract AT(30-1)-875)

(UR-875-218) CFSTI: HC $3.00/MF $0.65

A preliminary analysis of three-body reactions involving $\overline{Y}$ and Y production in 12.7 GeV/c K^++p interactions, and the production of quasi two-body final states in the reactions $K^+ + p \rightarrow K^0 + p + \pi^+$, $K^+ + p \rightarrow K^0 + p + \pi^+ + \pi^0$, and $K^+ + p \rightarrow K^+ + p + \pi^+ + \pi^-$. The film is from 80,000 exposures of the 80-inch liquid hydrogen chamber to an rf separated beam. NSA

N68-18064*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

STELLAR OPACITY PROGRAM MANUAL "STOP" Preliminary Report

Thomas E. Michels, Ira Kaskel, and Sheila Meyer Feb. 1968 65 p refs

(NASA-TM-X-63119; X-642-68-51) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The new Stellar Opacity program, "STOP" is described. "STOP" is the FORTRAN version of the IBM 7090 FAP, "OPACITY" and "IONIC" programs developed by Dr. Arthur N. Cox at the Los Alamos Scientific Laboratory. A Rosseland Mean Continuous Opacity is computed and the following processes are included: Bound-free and free-free absorptions including those of the H^2 ion, Compton electron scattering, H_2 and H+H molecular absorptions, and Electron conduction. Equations used for these processes as well as the "Mayer Independent Electron" and "Ionic" methods of computing occupation numbers and other equation of state data are discussed. "STOP" is available for general usage. Author

N68-18118*# Geophysics Corp. of America, Bedford, Mass.

STUDIES OF PHOTOABSORPTION BY ATOMIC HYDROGEN, OXYGEN, AND NITROGEN

R. B. Cairns and James A. R. Samson Washington Mar. 1968 119 p refs

(Contract NASw-1283)

(NASA-CR-998; GCA-TR-67-2-N) CFSTI: HC $3.00/MF $0.65 CSCL 20H

This report contains an account of experiments made to study the photoabsorption properties of atomic hydrogen, oxygen, and nitrogen. The ultimate objective was the quantitative measurement of atomic photoionization cross sections. The results of the experiments have been combined with recent theoretical estimates of the cross sections and information from spectroscopic studies. Author

N68-18128*# Harvard Coll. Observatory, Cambridge, Mass.

PARAMETERIZATION OF ABSORPTION-LINE PROFILES

Bruce W. Shore Nov. 1967 42 p refs

(Grant NsG-438)

(NASA-CR-93353; SR-23) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The parameterization for attenuation cross-sections is discussed, with attention to the following details: prescriptions of exact calculation of profile parameters, in which the effects of distortions are separated from the effects of multiple scatterings; the validity of assuming independent (noninterfering) resonances; the specific case of autoionizing lines; connections with alternative parameterizations; the prohibition on negative cross-sections assured by unitarity; behavior at threshold; and the applicability of this parameterization to emission lines. Author

N68-18152# Wuerzberg Univ. (West Germany). Physikalisches Institut.

BUBBLE DENSITY AND GROWTH OF BUBBLES IN PROPANE

P. Kunkel, G. Christenn, and M. Scheer *In* CERN Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 405-412 *ref* (See N68-18147 08-11)

Using 20 MeV electrons from a betatron and a small 350 cm pressure stabilized bubble chamber, the primary bubble density and the rate of bubble growth in propane were studied. Focused upon were the dependence of the two quantities on the working parameters of the chamber, i.e. the temperature and the pressure drop. Approximation methods for determining the rate of bubble growth from the actual bubble density without explicit knowledge of bubble diameter are described. The bubble density as a function of flash delay was measured for several combinations of temperature and pressure drop. As an example, results for a fixed temperature of 65.55°C are given. Primary bubble density values are plotted as a function of the pressure drop with the temperature as the parameter. For the two higher values of temperature, the maximum bubble density with 130 bubbles/cm were achieved. Curves of constant bubble density and curves of constant rate of bubble growth were plotted in a p,T-diagram, and comparative data on characteristics of the slopes of these curves are reviewed. S.C.W.

N68-18201# Illinois Univ., Urbana.

MODELING RELATIONSHIPS IN NEUTRON TRANSPORT THROUGH DUCTS AND CAVITIES Final Report, Jun. 1964-Sep. 1967

Justo Diaz Sep. 1967 30 p refs *Its* Nucl. Radiation Shielding Studies Rept. No. 5

(Contract N00228-66-C-0311)

(AD-663570)

If radiation reflection within a duct or cavity is treated by the usual albedo approximation, that is, on the assumption that radiation emerges from the wall at the same point at which it is incident, it is possible to establish modeling relationships between similar configurations differing only by a scale factor. The foregoing assumption is investigated, and it is found that the modeling relationships are approximately valid for fission neutrons as long as the linear dimensions are on the order of two and a half feet or more. This lower limit may be decreased if the effective reflection plane, which is always a few centimeters beneath the actual cavity interface, is utilized as the bounding surface of the duct or cavity. Author (TAB)

N68-18245# Naval Radiological Defense Lab., San Francisco, Calif.

CUMULATIVE FISSION YIELD AND HALF-LIFE OF ^{134}Sb

Arnaldo A. Delucchi, Allen E. Greendale, and Peter O. Strom 15 Jan. 1968 35 p refs

(Contract AT(49-2)-1167)

(USNRDL-TR-67-140; AD-663565)

The cumulative fission yield of 134Sb produced in thermal-neutron-induced fission of 235U was experimentally determined and the half-life of the nuclide was measured. The

cumulative fission yield and half-life are found to be 0.32 plus or minus 0.04 percent and 11.1 plus or minus 0.8 sec., respectively. From an examination of the isobaric yield curve obtained for the mass-134 chain, evidence is presented that isomerism may exist in either 134Sb or 134I. A nuclear level scheme for 134Sb which predicts two isomeric states for this nuclide is presented. From the experimental data, an upper limit of approximately 2 seconds is determined for the half-life of the proposed isomer. Author (TAB)

N68-18254*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
OPERATIONAL AMPLIFIERS FOR USE IN NUCLEAR SPECTROSCOPY
Theodore E. Fessler Washington Mar. 1968 28 p refs
(NASA-TN-D-4349) CFSTI: HC $3.00/MF $0.65 CSCL 18D

The design of pulse amplifier systems for use in nuclear research can be greatly simplified by the use of fast operational amplifiers. This report treats the design and use of operational amplifiers in circuits with rise times as low as 10 nanoseconds. A specific amplifier circuit is used to illustrate real amplifier performance. Phase-compensation methods and their relation to open-loop amplifier properties are described. Some closed-loop amplifier circuits are used to demonstrate practical phase compensation. Author

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N68-17218# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
EXPERIMENTAL STUDY OF ELECTRICAL CURRENTS TO A FLAT PLATE IN SUPERSONIC IONIZED FLOW
A. F. Burke Sep. 1967 53 p refs Prepared for Sandia Corp.
(Contract AT(29-1)-789)
(SC-CR-67-2748) CFSTI: HC $3.00/MF $0.65

An experimental study was conducted to measure electrical currents to a flat plate in a flowing plasma. The experiments were done in a pressure-driven shock tube at a free-stream electron density of 1.3×10^{11} cm $^{-3}$. Both ion and electron current saturation were found and the magnitude of the ion saturation current was within 20% of that predicted using continuum, weakly ionized gas flow theories. Author (NSA)

N68-17284# Nagoya Univ. (Japan). Inst. of Plasma Physics.
EXCITATION OF LOW FREQUENCY OSCILLATIONS AT UPPER HYBRID RESONANCE BY MICROWAVES
S. Hiroe and H. Ikegami Nov. 1967 12 p refs
(IPPJ-80) CFSTI: HC $3.00/MF $0.65

Low frequency oscillations are excited by microwaves at the upper hybrid resonance in the presence of d. c. magnetic field. The low frequency (f) satisfies a simple relation, $(f_{ci}/f)^2 + (f_{pi}/f)^2 = 1$, which is known as the lower hybrid resonance. There is a threshold power for the microwave to excite the oscillations. It is expected that the lower hybrid mode in plasmas is coupled with the Bernstein mode at the upper hybrid resonance through a strong nonlinear process. Author

N68-17319# California Univ., Livermore. Lawrence Radiation Lab.
CRITICAL ELECTRON-BEAM CURRENTS IN PLASMA [O KRITICHESKIKH TOKAKH ELEKTRONNOGO PUCHKO V PLAZME]
M. D. Rayzer, A. A. Rukhadze, and P. S. Strelkov Oct. 1967 9 p refs Transl. into ENGLISH from the Russian Rept.-98
(UCRL-TRANS-10147; Rept.-98) CFSTI: HC $3.00/MF $0.65

The stability problems involved in the production of high-current electron beams are described. NSA

N68-17387# United Kingdom Atomic Energy Authority, Culham (England).
EQUILIBRIUM, STABILITY, AND TRANSPORT PROCESSES IN A PLASMA IN TOROIDAL GEOMETRY
A. A. Galeev and R. Z. Sagdeev Sep. 1967 13 p refs Transl. into ENGLISH of the Russian Preprint, p 1-14 Conf. held in Stockholm, Aug. 1967
(CTO-416; NP-TR-1600) CFSTI: HC $3.00/MF $0.65

It is shown that in a sufficiently tenuous plasma in toroidal traps the transport process, due to binary collisions, may in fact, be speeded up considerably more. This is attributed to an effective increase in the frequency of the Coulomb collisions for the trapped particles. The stability limit of the plasma is determined with respect to the so-called drift-dissipative instability of trapped particles. From this one can then determine the density limits of a thermonuclear plasma when both classical and turbulent transport processes are fairly small. NSA

N68-17428*# California Univ., Berkeley.
A MACROSCOPIC QUASI LINEAR THEORY OF THE GARDEN HOSE INSTABILITY
Ronald C. Davidson and Heinrich J. Voelk Jan. 1968 17 p refs Prepared for MIT
(Grants NGR-05-003-220; NsG-496)
(NASA-CR-93155) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The quasilinear stabilization of the garden hose instability is discussed from a macroscopic point of view with closure in the fluid model obtained by neglecting the effects of heat flow. In order to keep the problem well posed mathematically finite Larmor radius corrections to the conventional growth rate are retained, which leads to a natural cut off in the growth rate for sufficiently large wave number. Author

N68-17430*# Gulf General Atomic, San Diego, Calif.
OPTICAL CONSTANTS OF URANIUM PLASMA Final Report
D. E. Parks, G. Lane, J. C. Stewart, and S. Peyton 2 Feb. 1968 295 p refs
(Contract NAS3-7961)
(NASA-CR-72348; GA-8244) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Thermodynamic and optical properties of a uranium plasma are calculated for conditions that obtain in proposed gaseous core nuclear rockets. As a quantitative basis for calculations, we begin with the relativistic wave mechanical description of a single electron moving in a spherically symmetric potential. The potential is a modified Thomas-Fermi potential containing an arbitrary parameter whose value we determine by calibration against one electron binding energies previously calculated by a relativistic, self-consistent field method. From the corresponding single particle wave functions, we calculate oscillator strengths and estimate the many electron properties of ions that are relevant to thermodynamic and optical properties. Particular emphasis is given to the often significant effects associated with the rich energy level and line spectra that appear in the spectroscopy of ions having several electrons in partially filled shells. Pressure ionization is treated in a manner that is approximately valid for nondegenerate gases for any ratio of Debye length to ion sphere radius and that satisfies the requirements of thermodynamic consistency. Specific results for composition, thermodynamic functions, and local and overall Planck and Rosseland mean opacities of uranium are given for the temperature range from 5000°K to 110,000°K and the pressure range from 100 to 1000 atmospheres. Finally, we compare the theoretical opacity at 5100°K and 3.58×10^{-4} atm with that inferred from the measured emission from an arc containing uranium. Author

N68-17629# Comitato Nazionale per l'Energia Nucleare Frascati (Italy). Lab. Gas Ionizzati.
NONLINEAR GENERATION OF TRANSVERSE FROM LONGITUDINAL FLUCTUATIONS IN AN INFINITE STABLE PLASMA

H. Bornatici and F. Engelmann Oct. 1967 26 p refs Sponsored in part by EURATOM
(LGI-67/19) CFSTI: HC $3.00/MF $0.65

The stationary spectrum of transverse electric field fluctuations, generated by nonlinear interaction of longitudinal waves, in a homogeneous and isotropic electron plasma of infinite extension and in the absence of external fields, is calculated. Only the lowest-order nonlinear effect, yielding transverse waves with frequencies close to 2 ω_p, is considered, including however, nonresonant modes. An estimate of the order of magnitude of the effect is given for equilibrium fluctuations. Author (ESRO)

N68-17638# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati.
DISCUSSION OF SOME EXACT TWO-DIMENSIONAL EQUILIBRIA OF VLASOV PLASMAS
A. Sestero Dec. 1967 15 p refs Sponsored in part by EURATOM
(LGI-67/27) CFSTI: HC $3.00/MF $0.65

A class of exact two-dimensional equilibria of Vlasov plasmas, which are easily expressible in terms of the real and imaginary part of an arbitrary analytic function in the complex plane, is discussed, particularly with regard to the peculiarities introduced in the solutions by the zeros and singularities of the generating function and of its derivative. Author (ESRO)

N68-17640# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati.
A NOTE ON THE PRODUCTION OF THIN PLASMA LINERS
J. G. Linhart Jun. 1967 19 p refs Sponsored in part by EURATOM
(LGI-67/12) CFSTI: HC $3.00/MF $0.65

Thin plasma liners are produced out of heavy gas and high concentrations of relatively cold plasma layers in front of a magnetic piston. The efficiency of energy transfer from a source of magnetic energy into the kinetic energy of the formed plasma liner and the thickness of the liner are calculated using a snow-plough model (plane geometry) and a shock model (cylindrical geometry). It is concluded that thin dense liners can be produced with relatively high efficiency. ESRO

N68-17647# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati.
ELECTROSTATIC OSCILLATIONS IN PLASMA
B. Bertotti Jun. 1967 51 p refs Sponsored in part by EURATOM
(LGI-67/10) CFSTI: HC $3.00/MF $0.65

The value of electrostatic potential of electric charges in plasma in thermal equilibrium is calculated. The dispersion of electrostatic oscillations of a single charged fluid is evaluated and the initial value for one-dimensional electrostatic oscillations is calculated using the Laplace Transform with respect to time. The problem of temperature effects in two-stream instability is dealt with leading to the dispersion relation corresponding to a discontinuous one-dimensional distribution function. ESRO

N68-17703# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STATISTICAL THEORY OF TURBULENCE IN PLASMA [K STATISTICHESKOY TEORII TURBULENTNOSTI V PLAZME]
Yu. L. Klimontovich *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 15-32 refs (See N68-17701 08-23)

Constructed is a system of equations for first distribution functions and a spacial spectral function of electric field strength for the radiative temperature region of plasma waves. The initial system is a system of microscopic equations for phase density of charged particles in different plasma components and for microscopic electric field strength. Under the conditions shown in this paper the derived system of equations describes development and disintegration of an uniform turbulence in the plasma. The hydrodynamic equations contain the damping decrement of plasma waves and the radiation temperature. Author

N68-17704# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HYDRODYNAMIC APPROXIMATION FOR IONIZED GAS IN STRONG ELECTRICAL FIELD [O GIDRODINAMICHESKOM PRIBLIZHENII DLYA IONIZOVANNOGO GAZA V SIL'NOM ELEKTRICHESKOM POLE]
V. M. Yeleonskiy and V. M. Zhdanov *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 33-41 refs (See N68-17701 08-23)

A consistent kinetic approach to the problem of ionized gas behavior in an external field leads to the analysis of connected kinetic equations for partial distribution functions that occur during decomposition. Hydrodynamic approximation methods for the kinetic approach determine the distribution function of the basic state of the deflections from the basic state. A time solution for the kinetic equation is obtained by decomposition into tensor polynomials based on the fundamental sequence of tensors 1, v_α, $v_\alpha v_\alpha$, v_β, $v_\alpha v_\beta$ v_γ, ... where the basic state is either a stationary solution for a zero external field or a solution for a non-collision kinetic equation. Here, the decomposition structure and type of polynomials are determined by orthogonalization of the fundamental sequence with a weight function determined by the distribution function for the basic state. Included is the decomposition into tensor hermite polynomials that occurs when the Maxwellian distribution function is taken as the ground state. Author

N68-17705# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STRUCTURE OF SHOCK WAVE IN RAREFIED NONISOTHERMAL PLASMA [STRUKTURA UDARNOY VOLNY V RAZREZHENNOY NEIZOTERMICHESKOY PLASME]
A. P. Kazantsev *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 43-51 refs (See N68-17701 08-23)

Experimental and astrophysical observations show that the width of a rarefied shock wave plasma may be substantially less than the length of the free particle path. It is obvious that the dissipation mechanism in such a shock wave is not connected with the collisions, but is apparently caused by excitation of coherent plasma oscillations in the transition layer. These oscillations are ordered in character during small dissipation and are also connected with non-linearities specific for a nonisothermal Maxwellian plasma. The oscillations may get turbulent in character through the instability of the plasma. An instability mechanism of this kind is considered anisotropic in the distribution of particles over speeds. Estimates obtain a shock wave width of the order of M/mq, where q is the reverse Debye radius. Finally considered is the excitation of "epithermal" fluctuations at shock wave fronts in connection with beam instability. Author

N68-17706# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THEORY OF SHOCK WAVES IN RELATIVISTIC MAGNETIC HYDRODYNAMICS [K TEORII UDARNYKH VOLN V RELYATIVISTSKOY MAGNITNOY GIDRODINAMIKE]
R. V. Doych *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 53-64 refs (See N68-17701 08-23)

This article studies the structure of weak shock waves on the basis of relativistic magnetohydrodynamic equations containing terms connected with dissipative effects. Expressions are derived for the change in thermodynamic and electromagnetic magnitudes inside the break. Shock wave width depending upon dissipative coefficients and the jump density magnitude are established. Also considered is the influence of thermoelectric phenomena on the shock wave structure. It is shown that due to thermoelectric phenomena inside the break a longitudinal electrical field and a corresponding double electrical layer is created. This phenomenon is nonrelativistic, but

there is a phenomenon produced by thermoelectric forces which proves to be purely relativistic. It consists of the fact that inside the burst the lines of force of magnetic field deviate from the plane, in which they normally break; the magnetic intensity lines before or after break are located. Given is the dependency of shock wave speed on the jump in pressure up to the first order. Author

N68-17707# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MODEL OF UNBALANCED PROCESSES IN CERTAIN PROBLEMS OF MECHANICS OF SOLID MEDIA [MODEL' NERAVNOVESNYKH PROTSESSOV V NEKOTORYKH ZADACHAKH MEKHANIKI SPLOSHNYKH SRED]

A. T. Onufriyev *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 65–79 refs (See N68-17701 08-23)

There are several branches of solid mechanics: the theory of transfer of radiant energy, the theory of rarefied gases, and the theory of turbulent transfer, where transfer processes can be linked to the integral nature of flow densities of different properties. When the free path length is greater than, or comparable with, characteristic dimensions of field change, the flow densities are determined by a transferable quantity distribution within the neighborhood of a point, namely within a region of the order of 2-3 free path lengths. An attempt is made to construct a simple model of transfer processes for certain linear problems with one-dimensional transfer which reflects the characteristic features of limiting cases in rarefied gas theory. It uses the phenomenon of free-molecular flow and Navier–Stokes equations with wall adhesion to obtain turbulent transfer at small values of path length by the semi-empirical Prandtl theory. For turbulent transfer the local-gradient description of transfer phenomena are discarded and kinetic equations are used. Author

N68-17809 Northwestern Univ., Evanston, Ill. Gas Dynamics Lab.

THE DIAGNOSTICS OF PLASMAS

John A. Thornton, Richard C. Warder, Jr., and Ali Bulent Cambel *In* AGARD Combust. and Propulsion 1967 p 377–418 refs (See N68-17793 08-03)

In energy conversion processes, both natural and man-made plasmas may be used to advantage. However, regardless of origin, it is necessary to know the properties of plasmas before reliable energy conversion devices can be designed and constructed. It is the purpose of this paper to highlight the theoretical considerations underlying plasma diagnostic techniques used in the gas dynamics laboratory in conjunction with a variety of plasma generation facilities. Author

N68-17810 Purdue Univ., Lafayette, Ind.

THERMODYNAMICS OF MHD ENERGY CONVERSION

Harold M. DeGroff and Richard F. Hoglund *In* AGARD Combust. and Propulsion 1967 p 419–475 refs (See N68-17793 08-03)

Previous theoretical and experimental work is reviewed with an over-all view of accessing the accuracy to which the performance of MHD Energy Conversion devices can be predicted. Both open- and closed-cycle linear magnetohydrodynamic generators are discussed. The recent progress made in open-cycle generators, with combustion reactions serving as the heat source, is described. Equilibrium thermodynamics is used to determine the theoretical performance of these generators. Particular attention is given to the loss mechanisms at the edges of the field regions and through the wall and electrode boundary layers. Existing experimental results are compared with the theoretical predictions. Major engineering problems are pointed out and discussed. In the case of closed-cycle generators, successful operation depends upon achievement of adequate electrical conductivity at relatively low temperatures. The most promising approach is through non-equilibrium ionization. The thermodynamic energy exchange processes which govern the extent of non-equilibrium ionization are discussed. Future prospects for development and key research areas pertinent to closed-cycle MHD power generation are described. Author

N68-17813 Naples Univ. (Italy).

GENERALIZED SAHA EQUATION FOR NON-EQUILIBRIUM TWO TEMPERATURE PLASMAS

R. Monti and L. G. Napolitano *In* AGARD Combust. and Propulsion 1967 p 517–537 refs (See N68-17793 08-03)
(Contract AF 61(952)-548)

The present work is intended as a higher approximation with respect to the theory which proposes the use of the Saha equilibrium equation based on the electron temperature; in the present analysis both electrons and atoms temperature are taken into account for the calculation of the equilibrium electron concentration. A thermodynamical analysis of a ternary plasma (composed by one species of atoms, one species of ions and electrons) is presented and the components of the mixture are considered ideal gases. The state equations of the mixture, considered as thermodynamic system with four degrees of freedom, are written therefrom obtaining the explicit expressions of the affinities (Ai) for the rate processes (i.e., ionization, A_1 and thermalization A_2). The usual form of the Saha equations is recovered when one sets $A_1 = A_2 = 0$ (conditions of "full" equilibrium). The generalized form of the Saha's equation is obtained when one lets only $A_1 = 0$, thus obtaining, upon the acceptable hypothesis of thermodynamic stability, an explicit expression relating the degree of ionization (α) to the three remaining state parameters of the mixture. As an application of this theory the electrical conductivity has been calculated under a number of suitable simplifying hypotheses, as a function of the plasma pressure and temperatures. The correlation of the available experimental results appears to be improved with respect to other more simplified theories. Author

N68-17868# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Aero Propulsion Lab.

ANALYSIS OF A 4-BAR MIRROR CUSP MAGNETIC FIELD BY MEANS OF AN ELECTRON ANALOG DEVICE

Elmer White Sep. 1967 16 p refs
(AFAPL-TR-67-79; AD-663425)

The theory of singly charged particles in a positive gradient magnetic field was demonstrated by use of a thin electron beam. Analytically derived orbits and beam shapes are experimentally verified in an electron analog device. A correlation between an electron orbit in a low magnetic field and a high energy proton in a high magnetic field is demonstrated analytically. The electron beam shapes in the presence of a 4-bar mirror cusp field derived in these experiments agree with the electron and proton orbital patterns derived analytically. Author (TAB)

N68-17870 Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati.

WAVE GROUP Progress Report, Jan. 1–Dec. 31, 1967

Jan. 1968 62 p refs Sponsored in part by EURATOM
(LGI-68/1) CFSTI: HC $3.00/MF $0.65

The first research program of the Wave Group devoted to experiments on density fluctuations in alkali plasmas without magnetic fields. Ion plasma oscillations and electron plasma oscillations have been induced by a proper use of sheath formation at the electrodes, and a comprehensive study of coherent forward scattering of electromagnetic radiation from such oscillations has been completed. The second program concerns the study of electrostatic oscillations in low-beta plasma, carried out in a Q-device. An experimental program involving electron cyclotron heating has been started. ESRO

N68-17872# Air Force Inst. of Tech., Wright-Patterson AFB Ohio. School of Engineering.

MOLIERE'S THEORY OF MULTIPLE COLLISIONS APPLIED TO THE SCATTERING OF AN ELECTRON BEAM INJECTED INTO A PLASMA

C. T. Case and E. L. Battle Sep. 1967 40 p refs
(AFIT-TR-67-16; AD-663925) CFSTI: HC $3.00/MF $0.65

The basic scattering theory of Moliere is presented and discussed. This discussion follows previous papers on the subject, but provides missing steps, alternative derivations, and interpretations and precautions peculiar to plasma applications. A section on plasma diagnostics under multiple scattering domination is included. The intent of the paper is that of giving the experimenter the results he needs to accurately interpret observed electron beam scattering in terms of the diffuse plasma through which the beam has passed. TAB

N68-17892*# Pittsburgh Univ., Pa. Space Research Coordination Center.

A MATHEMATICAL STUDY OF THE ELECTRON DECAY IN DIFFUSION AND RECOMBINATION CONTROLLED AFTERGLOWS: ANNALS OF PHYSICS

Lothar Frommhold (Texas Univ., Austin) and Manfred A. Biondi 26 Feb. 1968 71 p refs
(Grant NsG-416; Contract DA-31-124-ARO(D)-G-518)
(NASA-CR-93253; SRCC-71) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The continuity equation for electrons in a decaying plasma is solved numerically in three dimensions including a loss term quadratic in the electron density and an ambipolar diffusion term. The geometries investigated are the finite cylinder, the rectangular parallelepiped and some one-dimensional cases. The electron densities are averaged assuming weighting functions corresponding to various microwave probing field distributions and are therefore directly proportional to measured quantities obtained in microwave afterglow studies of recombination. The linear range of the computed reciprocal of the (averaged densities)$^{-1}$ *versus* time curves is determined and correction factors are derived which, if applied to the observations, yield the corrected recombination coefficients from the curves. The corrections derived in the two- and three-dimensional analyses are found to be significantly larger than those obtained in the one-dimensional analyses. Also, when considering plasma containers of different shapes but of the same fundamental diffusion length, a larger surface/volume ratio is found to be equivalent in effect to an increased diffusion coefficient in the predicted decays. Author

N68-17921# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ELEMENTARY PLASMA PHYSICS

L. A. Artsimovich 4 Apr. 1967 164 p Transl. into ENGLISH from the book "Elementarnaya Fizika Plazmy" Moscow, Gosatomizdat, 1963 p 1-192
(FTD-MT-65-443; AD-663932)

Plasma is the state of the substance most wide-spread in the cosmos and it has very interesting properties that find even wider use in work dedicated to the great problems of contemporary technology. However, the layman who wished to obtain a general idea of the properties of plasma meets a difficult problem. Most books on this subject have such powerful mathematical requisites that to decipher their contents it is necessary to have good preparation in the most important divisions of theoretical physics. At the same time, for an explanation of basic phenomena occurring in plasma, there is no need for complicated mathematical apparatus, which is frequently misused and, as a result, it sometimes obtains a decorative value. It is possible to try to expound the basic questions of plasma physics such that they could be comprehended by a reader with a reserve of knowledge in mathematics and physics approximately corresponding to a course in secondary school (high school). This book has such a purpose. However this does not mean that the reader is given everything in limiting facilitated form, adjusted for mastering without deliberation. In reference to plasma physics this is impossible, and inexpedient. The book sets forth not only ready results of analysis of different plasma processes, but usually also the approach to these results, because, only by considering them can one properly grasp the physical meaning of the phenomena. As a basis during all calculations the absolute CGS system of units is used. In certain cases the practical system of electrical engineering units is used also. Author (TAB)

N68-17953*# Massachusetts Inst. of Tech., Cambridge. Center for Space Research.

ELECTROCONVECTIVE INSTABILITY WITH A STABILIZING TEMPERATURE GRADIENT. 1: THEORY

Robert J. Turnbull (Ph.D. Thesis) Feb. 1968 30 p refs
(Grant NsG-368)
(NASA-CR-93333; CSR-TR-68-3) CFSTI: HC $3.00/MF $0.65 CSCL 20I

A uniform vertical electric field produces an instability in a poorly-conducting fluid subject to a vertical temperature gradient. A gradient in conductivity resulting from the temperature gradient causes free charge to accumulate in the fluid when an electric field is applied. For the cases considered the gradient in dielectric constant can be neglected with the significant electric force that is due to the free charge. The threshold conditions for the instability are predicted using linear perturbation theory. Approximations are made which allow the equations with space-varying coefficients to be solved. The analysis shows that, for fluids with short or moderate electrical relaxation times, the electric field causes the gravity wave propagating downward to become unstable. Author

N68-17955*# Massachusetts Inst. of Tech., Cambridge. Center for Space Research.

BANG-BANG DIELECTROPHORETIC ORIENTATION

James R. Melcher, David S. Guttman, and Mathew Hurwitz (Dynatech Corp.) Jan. 1968 28 p refs
(Contract NAS8-20553; Grant NsG-368; Contract AF 33(615)-3583)
(NASA-CR-93334; CSR-TR-68-1) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The Korteweg-Helmholtz force density on a homogeneous incompressible dielectric liquid immersed in an electric field is concentrated at interfaces. Hence, an electric field imposed with a strong gradient in the region of an interface has a marked effect on the fluid dynamics. As the interface passes from a field-free region through the gradient, the electric surface force "bangs" on. Experiments are described which demonstrate the influence of the electric field on modes of fluid oscillation. It is demonstrated that liquids such as freon and nitrogen can be susended in a stable equilibrium over a gas in an adverse, "one g" gravitational field. Experimental measurements of oscillation frequency and conditions for instability are correlated with a theoretical model which includes the salient non-linear features of the dynamics. Applications to slosh control and orientation of liquids in low gravity environments are discussed. Author

N68-18039*# Volt Technical Corp., Washington, D. C.

ESTIMATE OF PROTON TEMPERATURE OF INTERPLANETARY PLASMA ACCORDING TO DATA OBTAINED ON SPACECRAFT "VENERA-3" [OTSENKA TEMPERATURY PTOTONOV MEZHPLANETNOY PLAZMY PO DANNYM POLUCHEN NYM NA KOSMICHESKOM APPARATE "VENERA-3"]

T. K. Breus and K. I. Gringauz 7 Mar. 1968 5 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, no. 6, 1967 p 948-950
(Contract NAS5-12487)
(NASA-CR-93230; ST-PF-IPS-10685) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The estimates of proton temperature of interplanetary plasma on VENERA-3 are in fairly good agreement with the results obtained on MARINER-2, EXPLORER-10 IMP-2 and OGO-1. The authors attribute these temperatures to solar plasma proton perturbations rather than to conditions in the solar corona. Author

N68-18121*# Harvard Coll. Observatory, Cambridge, Mass.
CALCULATION OF IONIZATION EQUILIBRIA FOR OXYGEN, NEON, SILICON, AND IRON
John W. Allen and Andrea K. Dupree Nov. 1967 40 p refs
(Grant NsG-438)
(NASA-CR-93358; SR-24) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Ionization by electron collision, excitation by autoionizing levels by electron collision, dielectronic recombination, and radiative recombination are discussed in relation to the calculation of ionization equilibria for iron, neon, oxygen, and silicon; and effects of these processes upon the maximum abundance of an ion and the temperature required for ion production are considered. For most of the heavy ions or for those occurring at high temperatures, it is not necessary to consider effects of increased density; and when ionization is by electron impact from the ground state, a density independent solution appears to be adequate. M.W.R.

N68-18125*# Harvard Coll. Observatory, Cambridge, Mass.
DIELECTRONIC RECOMBINATION. 1: THEORY
Bruce W. Shore Oct. 1967 46 p refs
(Grant NsG-438)
(NASA-CR-93359; SR-22) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Dielectronic recombination (inverse autoionization) is treated as a special example of a resonance collision process; quantum scattering theory is used to parameterize the appropriate cross-section for resonance capture, with particular attention to overlapping levels, degeneracy, and the complete specification of angular momentum structure. Author

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N68-17239*# Motorola, Inc., Phoenix, Ariz.
BONDING LARGE AREA SILICON WAFERS Quarterly Report
[1967] 30 p refs Prepared for JPL
(Contracts NAS7-100; JPL-952022)
(NASA-CR-93195; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Results are reported on the development of techniques for bonding large area silicon single crystals to heat sinks. A method is described for preparing flat and parallel surfaces for large silicon wafers to reduce mechanical stress and to provide a known heat path. Aluminum-germanium eutectic solder has been successfully used to bond silicon to thick aluminum films deposited on Kovar alloy bases. The method used is not suitable for production, however, and a technique must be developed to eliminate effects attributed to the presence of silicon dioxide and aluminum oxide. Instruments available for measuring thermal and mechanical properties of solder alloys are briefly described and basic equations are generated for thermal conduction analysis and stress analysis. Author

N68-17248# Japan Atomic Energy Research Inst., Tokyo.
FREDAM-BI—A FORTRAN-4 PROGRAM FOR COMPUTATION OF THE FREQUENCY DISTRIBUTIONS OF BERYLLIUM AND ICE BY ROOT SAMPLING METHOD
Y. Nakahara and O. Kato (IBM-Japan) Oct. 1967 26 p refs
(JAERI-1146)

This program is one of the FREDAM-series which have been prepared for computing frequency distributions of hexagonal crystals. The purpose of this program is to evaluate the frequency distributions of beryllium and ice by a root sampling method. Prior to the computation of the frequency distribution, we solve the eigenvalue problem of the secular determinant by a modified Jacobi method. For the secular determinant we used the formula given by Nakahara in the case of beryllium and that by Forslind in the case of ice. Dispersion relations, polarization vectors and the generalized frequency distributions can also be calculated. This program is written in FORTRAN-IV and can be used both on IBM 7044 and IBM 7090. Author

N68-17278# Iowa State Univ. of Science and Technology, Ames.
THERMAL CONDUCTIVITY OF DYSPROSIUM, ERBIUM, AND LUTETIUM SINGLE CRYSTALS
Donald Waring Boys (Ph.D. Thesis) Nov 1967 80 p refs
(Contract W-7405-ENG-82)
(IS-T-185) CFSTI: HC $3.00/MF $0.65

The thermal conductivity of dysprosium, erbium, and lutetium single crystals has been measured as a function of temperature from 5 to 300°K. The measurements were made by the steady-state heat flow method. The electrical resistivity of these same crystals was also measured so that the Lorenz function could be calculated. The thermal conductivity of each element was measured along the ⟨0001⟩ (c-axis) direction and along a basal plane direction. In the paramagnetic temperature region considerable anisotropy exists between the basal plane and c-axis thermal conductivity. This is interpreted in terms of the anisotropic Fermi surfaces of the rare earths. Above the Debye temperature the thermal conductivity consists of phonon and electron contributions. Author (NSA)

N68-17279# Brookhaven National Lab., Upton, N. Y. Chemistry Dept.
DYNAMICS AND STRUCTURE IN MOLECULAR CRYSTALS. 1: SCATTERING METHODS AND INTERMOLECULAR FORCES: MODELS, TECHNIQUES, AND RESULTS
Walter C. Hamilton [1967] 61 p refs Presented at the 2d Symp. on Mater. Res., Mol. Dyn., and Struct. of Solids, Gaithersburg, Md. Sponsored by AEC
(BNL-11836; CONF-671028-1) CFSTI: HC $3.00/MF $0.65

The application of neutron diffraction and inelastic scattering to problems in molecular structure and dynamics is discussed. The interaction between spectroscopy and diffraction and the use of theoretical models is emphasized. The relationship between vibrational amplitude as determined by diffraction and vibrational frequency as determined by spectroscopic techniques is shown to be relatively independent of the shape of potential function assumed. Little information concerning shapes can be derived from either type of experiment. The quality of diffraction data is high enough so that the parameters of sensible models describing departures from harmonic motion can be refined from the diffraction data. Since internal modes are usually harmonic, it is suggested that the most suitable model for refinement of diffraction data may be one in which the vibrational amplitudes due to the internal modes are assumed and the remainder of the motion is refined in terms of anharmonic rigid body motions. Some speculation regarding the inpact of neutron inelastic scattering on the study of intermolecular forces is presented. Experimental results on the motions of the phosphonium ion in phosphonium iodide and the ammonium ion in ammonium fluorosilicate are discussed. It was concluded from an accurate neutron diffraction study that the short hydrogen bond in potassium hydrogen diaspirinate (*bis*-acetylsalicylate), a typical type A acid salt, is effectively of the symmetric single minimum type. An O–H stretching vibration of 500 to 1000 cm^{-1} is predicted. Author (NSA)

N68-17280# Iowa State Univ. of Science and Technology, Ames.
ANALYSIS OF ELECTRON SPIN RESONANCE SPECTRA OF THE GADOLINIUM ION IN SODA SILICA GLASSES

Robert Clair Nicklin (Ph.D. Thesis) Nov. 1967 121 p refs
(Contract W-7405-ENG-82)
(IS-T-203) CFSTI: HC $3.00/MF $0.65

The electron spin resonance of the Gd^{3+} ion was studied in two series of glasses having the molar compositions $6SiO_2{\cdot}5Na_2O{\cdot}x(Gd_2O_3 + Y_2O_3)$ with $0 \leq x \leq 0.5$ and $500SiO_2{\cdot}xNa_2O{\cdot}1Gd_2O_3$ with $2.5 \leq x \leq 494$. The spectra were nearly independent of temperature and sample composition, but varied strongly with microwave frequency in the range 5.4 to 38.4 GHz. Saturation and relaxation effects were noted at 9.8 GHz. Author (NSA)

N68-17281# Iowa State Univ. of Science and Technology, Ames.
PIEZORESISTANCE OF n-TYPE MAGNESIUM STANNIDE
Leon Duane Crossman (Ph.D. Thesis) Nov. 1967 144 p refs
(Contract W-7405-ENG-82)
(IS-T-198) CFSTI: HC $3.00/MF $0.65

The piezoresistance tensor components for n-type Mg_2Sn have been measured from 50 to 300°K. From these measurements and the elastic constants of Davis et al., the elastoresistance tensor components were obtained and found to satisfy $m_{11} = -2m_{12}$, m_{11} large and m_{44} small, in the temperature range 50 to 200°K. These relationships confirm that n-type Mg_2Sn is a many-valley semiconductor with constant energy ellipsoids in the (100) direction. The fact that m_{11} and m_{12} were both linear in the temperature range 60 to 175°K indicates that intervalley scattering is unimportant in the extrinsic temperature region. The small value of the volume coefficient, $(m_{11} + 2m_{12})/3$, indicates that carrier mobility in n-type Mg_2Sn is relatively insensitive to changes in sample volume. The deformation potential was determined from a combination of these piezoresistance results and Umeda's magnetoresistance data. High stress piezoresistance measurements yielded a deformation potential of $\Xi_u = 18$ eV and mobility anisotropy of $K = 2.65$ at 77.4°K. Umeda obtained $K = 3.51$. A possible qualitative explanation of these differences can be given in terms of a change with stress of the position of the donor levels with respect to the conduction band. Author (NSA)

N68-17282# Iowa State Univ. of Science and Technology, Ames.
OPTICAL PROPERTIES OF DILUTE SILVER–INDIUM ALLOYS IN THE ULTRAVIOLET
Relbue Marvin Morgan (Ph.D. Thesis) Nov. 1967 103 p refs
(Contract W-7405-ENG-82)
(IS-T-187) CFSTI: HC $3.00/MF $0.65

The optical constants of silver and five dilute silver–indium alloys were determined from reflectance and transmittance measurements in the spectral region between 3.35 and 4.28 eV on vacuum-evaporated films. The concentrations ranged from 0.5% to 4.1% indium, and the film thicknesses ranged between 1000 and 1600 Å. Changes induced by alloying in the complex dielectric constant were interpreted to indicate a shift of the $L_3 \rightarrow E_F$ transition to higher energy and a shift of the $L_2' \rightarrow L_1$ transition to lower energy. Because contributions to the dielectric constant of the two transitions overlap and because of the limited energy range investigated, no firm estimates of the magnitudes of the shifts could be made. The strength of the interband absorption in the alloys at low energies (energies below the onset in silver) appeared to be too strong to be accounted for by indirect transitions. Alloying-induced changes in the energy-loss function showed that the relatively undamped plasma resonance in silver near 3.8 eV becomes strongly damped as indium is added. The increase in damping was attributed partly to a decrease in the conduction electron relaxation time and partly to the shift of interband transitions so that they occur at the plasma energy. Data from measurements on films cooled to liquid helium temperature showed some sharpening of structure in the complex dielectric constant and of the peak in the loss function. The changes produced by cooling became increasingly subtle with increasing indium concentration. Author (NSA)

N68-17285# California Univ., Berkeley. Lawrence Radiation Lab.
EFFECT OF THE MICROSTRUCTURE ON THE SUPERCONDUCTIVE PROPERTIES OF Nb_3Sn IN A NbC MATRIX
Jean Chabanne (M.S. Thesis) Sep. 1967 34 p refs
(Contract W-7405-ENG-48)
(UCRL-17826) CFSTI: HC $3.00/MF $0.65

Methods of hot-press processing of powder of Nb, Sn, C starting with various compositions have been investigated. The sintered product consists of grains of NbC surrounded by Nb_3Sn. Critical temperature measurements, X-ray diffraction, microprobe investigations, and critical field (H_{c2}) measurements in a pulsed field at 4.2° K have been made. A critical field of 240 kG at 4.2° K (J perpendicular to H) has been obtained by extrapolation for one of the samples. The current density was still 5000 A/cm^2 at 203 kG. Previous ways of manufacturing Nb_3Sn are described along with objectives of present efforts. Fabrication methods are discussed and descriptions are included on the variation of structure versus composition and versus heat treatment. The T_c results are presented and correlated to the heat treatment. NSA

N68-17300*# Auburn Univ., Ala. Physics Dept.
BREAKDOWN CONDUCTION IN THIN FILMS OF SiO, MgF_2, CaF_2, CeF_3, CeO_2 AND TEFLON Final Report
Paul P. Budenstein Feb. 1968 129 p refs
(Grant NGR-01-003-011)
(NASA-CR-93153) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Breakdown studies on thin film dielectrics are reported covering the materials SiO, MgF_2, CaF_2, CeF_3, CeO_2, and Teflon. Experimental data includes prebreakdown V-I-T characteristics, impedance–temperature characteristics at 1000 cycles/sec, voltage threshold for the onset of breakdown vs temperature and dielectric thickness, voltage threshold for the cessation of breakdown vs temperature and thickness, time-resolved spectroscopy of the light emitted during breakdown, photomicrography of breakdown sites, and some additional observations. A critique of the theoretical treatments is given pointing out that none of them is completely successful in describing both the thickness and temperature dependence of the average field for the onset of breakdown. None of the theories attempt to describe conduction during the breakdown period. Author

N68-17349*# Illinois Univ., Urbana. Coordinated Science Lab.
AN EXPERIMENTAL INVESTIGATION OF RADIATION EFFECTS IN SEMICONDUCTORS Semiannual Status Report, Jul. 1–Dec. 31, 1967
W. Dale Compton 31 Dec. 1967 31 p refs
(Grant NsG-228-62; Contract DAAB07-67-C-0199)
(NASA-CR-93151) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The microscopic nature of the stable defects formed by the combining or interacting of simple primary defects, vancancies, interstitials, and impurities is investigated. The luminescence arising from the recombination of electrons and holes in silicon irradiated with fast neutrons and gamma rays are discussed. Preliminary measurements of luminescence of unirradiated germanium are mentioned. A discussion is also presented on hole-optical phonon interactions in degenerate silicon in tunneling measurements. It is suggested that the interactions result in modifications in the bulk semiconductor states above and below the Fermi energy. N.E.N.

N68-17385# Lockheed Missiles and Space Co., Sunnyvale, Calif.
ELECTRICAL CONDUCTIVITY OF VANADIUM OXIDE AT LOW TEMPERATURES
S. M. Ariia, B. Ia. Brach, and V. A. Vladimirova [1967] 3 p refs Transl. into ENGLISH from Vestn. Leningr. Univ., Ser. Fiz. i Khim. (Leningrad), no. 22, 1967 p 157–159

In order to clarify the specific band model of vanadium oxides, the temperature dependence of electrical conductivity in

samples of the lower oxides of vanadium was plotted in the range from 83° to 293°K. It is shown that a jump change in the electrical conductivity holds only in samples containing the $VO_{1.50}$ phase, characterized by the presence of a tranformation at about 170°K, and expressed in an abrupt change in both the electrical conductivity and magnetic susceptability. The electrical conductivity was measured in a cryostat with automatic maintenance of constant temperatures by a dc compensation method. The influence of thermal emf, originating in the electrical conductivity measurement loops because of the inevitable presence of some temperature gradients along the sample, was eliminated by commutating the current passing through the sample. E.J.S.

N68-17483*# California Univ., Berkeley. Space Sciences Lab.
INVESTIGATION OF KILOVOLT ION SPUTTERING Final Report
Harold P. Smith, Jr. 30 Jun. 1967 106 p refs /its Ser. 8, Issue 104
(Contract NAS3-5743)
(NASA-CR-72344) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The yield (ejected atoms/incident ion) and the angular distribution of ejected particles (atoms $ion^{-1}sr^{-1}$) are presented for various experimental conditions. Highly polished, monocrystalline surfaces of Cu, Mo, Ni, Al, and Al_2O_3 were bombarded by either Cs^+ or Hg^+, two ion species which find application in ion rocket propulsion. The yield and angular distribution were measured as functions of energy of the incident ion ($1<E<10$ keV), angle of incidence with respect to the target surface, crystallographic orientation of the target with respect to the surface and to the incident ion beam, temperature of the target, and partial pressure of oxygen. Among the major conclusions are: (1) The yield can be significantly reduced by directing the incident beam along low index crystallographic directions. (2) Normal incidence significantly reduces yield. (3) Short term annealing reduces the yield of refractory materials at higher temperatures; however, temperature has little effect on the non-refractory materials. (4) Reactive gas film formation at the metalic surface can significantly reduce yield, thereby showing the need for ultrahigh vacuum testing of ion rocket engines. Author

N68-17560# Lockheed Missiles and Space Co., Sunnyvale, Calif.
OPTICAL INVESTIGATIONS OF STRONGLY DOPED N AND P TYPE INAS
Iu. I. Ukhanov and U. Zhumakulov 1967 3 p refs Transl. into ENGLISH from Izv. Akad. Nauk Uz. SSR, Ser. Fiz. Mat. Nauk (Tashkent), no. 6, 1967 p 61–63

The results of optical investigations of n- and p-type indium arsenide in the 100° to 400°K temperature range are presented. The results show that the absorption edge shifts 0.58 eV into the shortwave region of the spectrum as the doping deepens for n-type with a 5×10^{19} cm^3 concentration at 300°K. Author

N68-17594*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
DAMPING OF A TORSIONAL OSCILLATOR IN LIQUID HELIUM 4 AND 3 FROM 0.4° TO 2.5°K
Rayjor W. H. Webeler and David C. Hammer Washington Mar. 1968 refs
(NASA-TN-D-4381) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The logarithmic decrements of a piezoelectric cylindrical quartz crystal driven in a torsional mode of vibration were determined as a function of temperature with the crystal immersed in liquid He^3 and He^4. These measurements were used to calculate the applicable "viscosity–density" product of these two liquids as a function of temperature. The results in the interval 2.14° to 2.20°K represent the most extensive and precise viscosity-density values for He^4 that are available to data. Inspection of this viscosity-normal density product ($\eta_n\rho_n$) data near the lambda point (T_λ) indicates that a discontinuity in ($\eta_n\rho_n$) data may exist. Results between 2.0° and 1.35°K in liquid He^4 are in agreement with three other investigations. Between 1.1° and 0.95°K, the data substantiate only the rotating viscometer results of Woods and Hollis Hallett. At temperatures below 0.6°K, the phonon density temperature dependence is $T^{4.0\pm0.1}$, confirming the temperature dependence of the Landau expression for the phonon density. With the torsional crystal technique there was evidence of suppression of the phonon viscous contribution. Viscosity values for liquid He^3 were determined between 0.4° and 2.5°K and are compared with the results of other investigators. Author

N68-17613*# National Aeronautics and Space Administration, Washington, D. C.
INVESTIGATION OF RECRYSTALLIZATION OF THIN FILMS UNDER THE EFFECT OF ELECTRON BOMBARDMENT [ISSLEDOVANIYE REKRISTALIZATSII TONKIKH PLENOK POD VLIYANIYEM ELEKTRONNOY BOMBARDIROVKI]
A. N. Pilyankevich, V. P. Zakharov, and V. N. Chugaev Nov. 1966 5 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Fiz. (Moscow), v. 30, no. 5, May 1966 p 789–792
(NASA-TT-F-10466) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Comparative study of the change in structure of thin films of germanium and silicon exposed to electron bombardment and thermal annealing. It is found that the temperature gradient arising during electron irradiation and the motion of the temperature front due to the thermal conductivity of the film results in recrystallization and the formation of large single crystals at thicknesses an order less than those observed by Gilbert et al. It is shown that, in contrast to previously prevailing opinion, recrystallization can occur in covalent crystals in the solid phase. Author

N68-17644# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).
ELECTRON PARAMAGNETIC RESONANCE IN SEMICONDUCTORS [RESONANCE PARAMAGNETIQUE ELECTRONIQUE DANS LES SEMICONDUCTEURS]
M. Do Khac Dec. 1967 29 p refs In FRENCH
(CERTS-NT-02-4) CFSTI: HC $3.00/MF $0.65

After having recalled the basic notions of electron paramagnetic resonance and band theory in semiconductors, and explained the physical meaning of the corresponding terminology, the author gives a brief description of modern electron paramagnetic resonance spectrometers and sets forth some applications of the E.P.R. in the study of semiconductor materials. ESRO

N68-17649# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).
INTRODUCTION TO THE STUDY OF RADIATION EFFECTS ON SILICON [INTRODUCTION A L'ETUDE DU COMPORTEMENT DUE SILICIUM SOUS IRRADIATION]
A. Roizes Nov. 1967 12 p refs In FRENCH
(CERTS-NT-02-1) CFSTI: HC $3.00/MF $0.65

Effects of radiation on the basic material of semiconductors on the temperature range $-100°C \div 100°C$. The importance of the role of initial impurities in crystals has been developed. Energy levels of particles in the forbidden band after irradiation are analyzed with reference to different types of impurities. ESRO

N68-17657# Rutgers Univ., New Brunswick, N. J. Dept. of Physics.
RELAXATION OF THE SUPERCONDUCTING ORDER PARAMETER

James W. F. Woo and Elihu Abrahams 14 Dec. 1967 27 p refs
(Contract Nonr-404(13))
(AD-663463)

The report considers the non-equilibrium behaviour of a pure type I superconductor and takes into account the effects of the electron-phonon interaction. The formulation is based on Kadanoff-Baym transport equations suitably generalized to the case of superconductors. In order to investigate the relaxation behaviour of the order parameter due to real phonon transitions, we solve the transport equations in the spatially homogeneous case when there is a slow time variation of the energy gap function. We solve the transport equations treating the real phonon transitions in the weakest possible way, much in the spirit of the BRT transport equation used in the treatment of thermal conductivity. We discuss in detail, however, why the BRT equation fails in this case, and gap relaxation rate (10 to the 8th power to 10 to the 9th power/sec) is about an order of magnitude slower than the quasi-particle decay rate but that very close to T sub c it disappears as T-T sub c. TAB

N68-17658# Rutgers Univ., New Brunswick, N. J. Dept. of Physics.
AN ANOMALY IN THE ULTRASONIC ATTENUATION IN STRONG COUPLING AND IMPURE SEMICONDUCTORS
Sang Boo Nam 14 Dec. 1967 13 p refs
(Contract Nonr-404(13))
(AD-663465)

General expressions for the ultrasonic attenuation response are derived by using a Greens function method. They are sufficiently general to apply to strong coupling superconductors and to superconductors with magnetic impurities. In the appropriate limit the BCS result is obtained. The coefficient of the ultrasonic attenuation consists of two terms; one comes from scattering at frequencies below the effective energy gap, and the other from exciting pairs of quasiparticles from the ground state to above the gap. This second process yields a discontinuity in the coefficient of the ultrasonic attenuation in the superconducting state. The discontinuity vanishes when the singular behaviour in densities of states and of pairs disappears, but its derivative with respect to the temperature has a discontinuity. In the weak coupling limit r becomes one, and the previous result is recovered. Our calculation accounts very well recent experiments of alpha sub S in Al, Hg, and Pb. TAB

N68-17673# Freie Univ., Berlin (West Germany).
EXPERIMENTAL DETERMINATION OF THE EFFICIENCY OF A NaI(Tl) SCINTILLATION DETECTOR FOR THE γ-RAYS OF ^{137}Cs AND ^{60}Co IN A FREE RADIATION GEOMETRY [EXPERIMENTELLE BESTIMMUNG DER EFFICIENCY EINES NaJ(Tl)-SZINTILLATIONSDETEKTORS FUER DIE γ-STRAHLEN VON ^{37}Cs UND ^{60}CO IN FREISTRAHLGEOMETRIE]
Burkhard Christmann 1966 63 p refs In GERMAN
(NP-17072)

The experimentally determined integral efficiency of a 1.5 inch × 2 inch NaI(Tl) cylindrical crystal in free radiation geometry was given for distances up to 20 cm. ^{60}Co (mean quantum energy of 1.25 MeV) and ^{137}Cs (662 keV) solutions of various activity were used as sources. The absorption in a spherical source was calculated and an estimation was made of the effect of the expansion of the source on the measured efficiency. A comparison of the results with the calculated efficiency for a point source showed that the measured value in the middle of the distance region considered agrees with the calculated values. At the largest gaps however it is approximately 7% larger and at distances of one cm approximately 15% smaller. The differential spectrum was used for detection of the quanta which reach the crystal. The effect of the nonproportionality between the γ energy or the electron energy and the luminescent yield of the crystal was considered on the differential spectra. An additional correction was given both for the differential spectrum and for the integral measurement from the time coincidence of the γ quanta in ^{60}Co. The error of the measurements by scattering in the crystal environment was experimentally determined and eliminated. Author (NSA)

N68-17676# Massachusetts Inst. of Tech., Cambridge. Crystal Physics Lab.
A STUDY OF THE PHYSICAL PROPERTIES OF HIGH-TEMPERATURE SINGLE CRYSTALS Final Report, 16 May 1962–30 Jun. 1967
Alexander Smakula 30 Sep. 1967 128 p refs
(Contract AF 19(628)-395)
(AFCRL-67-0645; TR-11; AD-663734)

A great variety of single crystals were grown and their physical properties studied. Crystals of metal oxides MnO, CoO, NiO, and mixed crystals of MnO-CoO, MnO-NiO, and CoO-NiO were grown by flame fusion and their electrical properties (dielectric constant and conductivity) and optical properties (refraction and absorption) as a function of frequency and temperature determined. The paraelectric properties of KTaO3 and the ferroelectric properties of KTaO3-NaTaO3 and KTaO3-KNbO3 were investigated as a function of composition and temperature. The dielectric properties of alkali halides, thallium halides, copper halides, and alkaline earth fluorides were measured over a wide frequency and temperature range. In semiconducting crystals (Si, Ge, and GaAs), dielectric anomalies were detected at low temperatures. The method for crystal growth of fluorides was improved, and single crystals of KMgF3, RbMnF3, and YLiF4 were grown and their optical properties determined. The perfection of crystals was studied by ultraviolet and infrared absorption, by high precision lattice constant, and high precision density measurements. The mechanical properties were studied by microhardness measurement. The microhardness of mixed crystals was studied in particular. Author (TAB)

N68-17767# Arizona State Univ., Tempe. Dept. of Chemistry.
SEMI CONDUCTING PROPERTIES OF CUPROUS OXIDE AND RELATED RESEARCH Final Scientific Report
Michael O'Keeffe Oct. 1967 74 p refs
(Grant AF-AFOSR-719-65)
(AFOSR-68-0030; AD-663435)

The report summarizes the research on semiconducting properties of cuprous oxide performed under this grant. Contributions have been made to the understanding of the behavior of cuprous oxide at high temperatures with special reference to the electrical properties and defect structure. Interdiffusion studies by thermogravimetric means have been made on wustite and manganous oxide. Further work is being continued under another grant. TAB

N68-17822 Texas A&M Univ., College Station.
MECHANISM OF ELECTRICAL CONDUCTIVITY OF FUSED SALTS
Fredrick R. Duke *In* AGARD Combust. and Propulsion 1967 p 709–715 refs (See N68-17793 08-03)

The lack of correspondence between viscosity and electrical conductivity, and particularly the temperature coefficients of these properties, indicates that Stokes' law does not apply to the motion of the ions in a fused salt. Experiments on transport numbers and on relative mobilities of ions in mixtures indicate that the conductivity process is poly order in the moving ion; that is, the ions would appear to move in groups. One interpretation of this effect is that an ion vacancy moves, in each activation step, through several or many ionic diameters. Bivalent cations in biunivalent salts tend to move very slowly. This is possibly due to the absence of binegative holes in the melt, making it necessary for the ions to move as singly charged ion pairs in conjunction with the anion present. Evidence concerning these hypotheses is presented. Author

N68-17827 Rice Univ., Houston, Tex. Solid State Energy Conversion Research Lab.

QUANTUM EFFICIENCY OF RADIANT ENERGY PHOTONS IN SEMICONDUCTORS

G. C. Jain *In* AGARD Combust. and Propulsion 1967 p 843–861 refs (See N68-17793 08-03)

The efficiency of conversion of radiant energy from the sun, nuclear or fossil fuels to electrical energy depends upon the efficiency with which a radiant energy photon is capable of generating a useful charge carrier. Using Shockley–Read statistics a general expression for the quantum efficiency of a monochromatic incident radiant photon has been derived in terms of the absorption coefficient $(L_\gamma)^{-1}$ of the incident wave-length in the semi-conductor material, the minority carrier lifetime and the thickness of the exposed layer of the P–N cell. Germanium cells show a great potential for solid-state conversion of energy from radiant sources. An analysis of the results for Germanium cells indicate that there is a strong dependence of the quantum efficiencies on the thickness of the exposed layer. Assuming an N–P cell, quantum efficiencies of 90 per cent and higher could be obtained for all wave-lengths from very small values to 1.5×10^{-4} cm, if the thickness of the exposed N layer is kept in the range of 50 to 250 microns. For monochromatic wave-lengths greater than 1.5 microns but less than 1.77 microns, the cut-off wave-length for germanium, the quantum efficiency decreases rapidly with increasing wave-length. It would, therefore, seem desirable that the radiant energy photons of wave-lengths 1.6–1.77 μ be reflected back and conserved. Because of the unavoidable impurities in the cell, the lifetime of minority charge carriers is reduced. A reduction in life-time reduces the quantum efficiency. Variations of the optimum thickness of the exposed layer has been worked out for various values of minority carriers' diffusion lengths.

Author

N68-17865# Maryland Univ., College Park. Center of Materials Research.

MATERIALS SCIENCES PROGRAM Technical Report, 1 Jul. 1966–30 Jun. 1967

30 Jun. 1967 120 p refs Sponsored by AEC, ARPA, NSF, NASA, AFCRL, and Others

(AD-663744)

Brief summaries are given of the progress and results of research activities in the following general areas: (1) high pressure phenomena, (2) intermolecular interactions, spectra, and structure, (3) electric and magnetic properties of materials, (4) electronic structure and fundamental interactions in solids, (5) interaction of matter and electromagnetic radiation, (6) thermodynamics and kinetics of reactions in materials, and (7) mechanical properties.

TAB

N68-17902*# Aztec School of Languages, Inc., Acton, Mass. Research Translation Div.

PHASE TRANSITIONS IN FERROELECTRICS [O FAZOVYKH PEREKHODAKH V SEGNETOELEKTRIKAKH]

V. G. Vaks, R. M. Galitskiy, and A. I. Larkin Washington NASA Feb. 1968 42 p refs Transl. into ENGLISH from the Russian Rept. IAE-1420, 1967 47 p

(Contract NASw-1692)

(NASA-TT-F-11468; IAE-1420) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The statistics and dynamics of displacement type phase transitions in ferroelectrics are described in microscopic terms. The coefficients of the Devonshire expansion of the free energy are expressed through the microscopic parameters. The correlation effects in the transition region are examined. The spectrum of the low-frequency vibrations above and below transition point is found.

Author

N68-17931# National Bureau of Standards, Washington, D. C.

ADSORPTION ON SINGLE CRYSTAL PLANES

Russell D. Young and Howard E. Clark Wright-Patterson AFB, Ohio ARL Sep. 1967 37 p refs

(Contract DO 33(615)-66-5006)

(ARL-67-0198; AD-663427)

A working instrument has been developed and tested for measuring work functions of perfect single crystal planes. The longstanding high work function value (6.0 eV) for emission from the (110) plane of tungsten was investigated using the new FN plus energy distribution technique. The new results yield still higher work function values than previously reported (8.8 eV). A theory has been developed to include the influence of surface patch fields from adjacent single-crystal planes on field emission from single-crystal planes. This theory led to a new method for interpreting field emission data which removes the influence of patch fields. It has been shown that the high work function values can be explained, at least in part, by assuming that electrons are emitted in pairs. This was studied experimentally and it was concluded that electrons are not in fact emitted in pairs. Preliminary experiments employing strontium adsorbed on tungsten demonstrate that the arrival of single strontium atoms at the surface can be detected. Thus the theory of Duke and Alferieff can be checked experimentally.

Author (TAB)

N68-17939# International Business Machines Corp., Hopewell Junction, N. Y. Components Div.

SEMICONDUCTOR JUNCTION PROPERTIES AS INFLUENCED BY CRYSTALLOGRAPHIC IMPERFECTIONS

Guenter H. Schwuttke Aug. 1967 328 p refs

(Contract AF 19(628)-5059)

(AFCRL-67-0564; SR-2; AD-663723)

Complex x-ray diffraction phenomena associated with diffused semiconductor junctions are successfully correlated with the performance of the semiconductor junction. The technique of x-ray stress topography is established that permits a rapid nondestructive analysis of the stress environment of film/crystal interfaces. Based on dynamical diffraction phenomena that occur at such interfaces, the technique is useful principally to measure the sign of the stress in film and/or substrate and to detect stress buildups and stress reversals connected with processing procedures -- in particular with those of the planar semiconductor device technology. Also, phosphorus diffusion into silicon is explored near and above the solubility limit through radiochemical profiling and compared with crystal damage by x-ray diffraction microscopy and Sirtl etch techniques.

Author (TAB)

N68-17988# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RADIATION PHYSICS. 1: ION CRYSTALS

5 Apr. 1967 213 p refs Transl. into ENGLISH of the Publ. "Radiatsionnaya Fizika. 1: Ionnyye Kristally" Riga, Izd. Akad. Nauk Latv. SSR, 1964 p 1–187

(FTD-MT-65-370; AD-663351)

CONTENTS:

1. INVESTIGATION OF RADIOLUMINESCENCE ALKALI-HALIDE CRYSTALS IN THE HORIZONTAL CHANNEL OF A REACTOR D. K. Shvarts, D. Yu. Lusis, and Yu. A. Ekman p 1–9 refs (See N68-17989 08-22)

2. INVESTIGATION OF THE PROCESSES OF GENERATION OF RADIATION DEFECTS IN IONIC CRYSTALS Ch. B. Lushchik, G. G. Liyd'ya, M. A. Elango, and A. V. Yaak p 11–23 refs (See N68-17990 08-26)

3. THERMOLUMINESCENCE OF KCl AND KCl-Tl CRYSTALS IRRADIATED IN A REACTOR K. K. Shvarts and Ya. Zh. Kristapson p 25–30 refs (See N68-17991 08-26)

4. INVESTIGATION OF RADIATION CREATION AND ANNEALING OF VACANCIES IN IONIC CRYSTALS BY THE METHOD OF CONTROL COLORING M. A. Elango p 31–40 refs (See N68-17992 08-26)

5. MEASURING THE FLUXES OF FILTERED RADIATION OF A REACTOR K. K. Baltmugur and D. Ya. Gubatova p 41–44 refs (See N68-17993 08-22)

6. PHOTOSTIMULATED EMISSION FROM COLORED NaCl AND KCl CRYSTALS A. I. Belkind and L. Ye. Nagli p 45–62 refs (See N68-17994 08-26)

7. THE EFFECTS OF IONIZING RADIATION ON PHOTOSTIMULATED EMISSION FROM CRYSTALS NaCl AND KCl A. I. Belkind and R. I. Kalendarev p 63–66 refs (See N68-17995 08-26)

8. THERMAL QUENCHING OF X-RAY LUMINESCENCE OF CERTAIN ALKALI-HALIDE PHOSPHOR CRYSTALS K. K. Shvarts, E. D. Aluker, I. P. Mezina, and M. M. Grube p 67–80 refs (See N68-17996 08-26)

9. TEMPERATURE DEPENDENCE OF THE AMPLITUDE OF GAMMA-SCINTILLATIONS IN CsI-Tl AND KI-Tl E. D. Aluker p 81–83 refs (See N68-17997 08-26)

10. INVESTIGATION OF ELECTRON PARAMAGNETIC RESONANCE AND LUMINESCENCE OF SOLID SOLUTIONS OF SODIUM AND MANGANESE CHLORIDE K. K. Shvarts, V. B. Layzan, and A. F. Lyushina p 85–87 refs (See N68-17998 08-26)

11. ELECTRON PARAMAGNETIC RESONANCE OF MANGANESE IN NaCl CRYSTALS WITH CADMIUM AND CALCIUM IMPURITIES V. B. Layzan and A. Ya Vitol p 99–114 refs (See N68-17999 08-26)

12. KINETICS OF INTRACENTER LUMINESCENCE OF A KCl-Pb PHOSPHOR CRYSTAL M. F. Trinkler p 115–125 refs (See N68-18000 08-26)

13. INVESTIGATION OF THE KINETICS OF INTRACENTER LUMINESCENCE IN A KCl-Tl CRYSTAL A. K. Everte p 127–140 refs (See N68-18001 08-26)

14. ON THE KINETICS OF INTRACENTER LUMINESCENCE OF KBr-Tl I. K. Plyavin' and B. Ya. Berzin' p 141–154 refs (See N68-18002 08-26)

15. INVESTIGATION OF THE LUMINESCENCE OF KI-Tl CRYSTAL 1: Excitation in an Absorption Band that Corresponds to $^1S_0 \rightarrow {}^3P_1$ Transitions B. Ya. Berzin' p 155–166 refs (See N68-18003 08-26)

16. INVESTIGATION OF THE LUMINESCENCE OF A KI-Tl CRYSTAL 2: Excitation In an Absorption Band That Corresponds to $^1S_0 \rightarrow {}^3P_1$ Transitions B. Ya. Berzin' p 167–174 refs (See N68-18004 08-26)

17. INVESTIGATION OF THE LUMINESCENCE OF A KI-Tl CRYSTAL 3: Excitation in the Exciton Absorption Band B. Ya. Berzin' p 175–177 refs (See N68-18005 08-26)

N68-17990# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF THE PROCESSES OF GENERATION OF RADIATION DEFECTS IN IONIC CRYSTALS [ISSLEDOVANIYE PROTSESSOV GENERATSII RADIATSIONNYKH DEFEKTOV V IONNYKH KRISTALLAKH]

Ch. B. Lushchik, G. G. Liyd'ya, M. A. Elango, and A. V. Yeak *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 11–23 refs (See N68-17988 08-26)

The authors investigated the color centers and purely ionic radiation defects that appear in NaCl crystals during irradiation in the vertical channel of an IRT reactor and also under X- and ultra-violet radiation. The spectra of the color centers created by ultraviolet radiation in ionic crystals are also investigated. Author

N68-17991# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMOLUMINESCENCE OF KCl AND KCl–Tl CRYSTALS IRRADIATED IN A REACTOR [TERMOLYUMINESTSENTSIYA KRISTALLOV KCl I KCl–Tl, OBLUCHENNYKH V REAKTORE]

K. K. Shvarts and Ya. Zh. Kristapson *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 25–30 refs (See N68-17988 08-26)

The authors show that irradiation of KCl and KCl–Tl crystals in a reactor (integrated flux of thermal neutrons $5 \cdot 10^{17}$ N/cm^2) creates deep levels of capture that correspond to additional absorption in the ultraviolet region. The spectra of additional absorption and thermoluminescence for KCl and KCl–Tl differ and depend on the concentration of thallium, the flux density and the integral flux of reactor radiation. In all crystals we observed neutron-induced radioluminescence. Author

N68-17992# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF RADIATION CREATION AND ANNEALING OF VACANCIES IN IONIC CRYSTALS BY THE METHOD OF CONTROL COLORING [ISSLEDOVANIYE RADIATSIONNOGO SOZDANIYA I OTZHIGA VAKANSIY V IONNYKH KRISTALLAKH METODOM KONTROL'NOGO OKRASHIVANIYA]

M. A. Elango *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 31–40 refs (See N68-17988 08-26)

The possibilities of applying the method of control coloring to investigate radiation creation and annealing of vacancies in ionic crystals are analyzed. The creation of radiation defects in NaCl monocrystals during irradiation in a reactor and by X-rays and also their annealing in nonisothermal conditions are studied. It is shown that annealing of anionic vacancies occurs at higher temperature than thermal desctruction of F-centers. Author

N68-17994# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

PHOTOSTIMULATED EMISSION FROM COLORED NaCl AND KCl CRYSTALS [FOTOSTIMULIROVANNAYA EMISSIYA S OKRASHENNYKH KRISTALLOV NaCl I KCl]

A. I. Belkind and L. Ye. Nagli *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 45–62 refs (See N68-17988 08-26)

The authors investigated the effect of ultraviolet light and X-rays on the stimulation spectrum of photostimulated emission (PSE) from NaCl and KCl crystals. We showed that the difference in the stimulation spectra is connected with the density distribution of color centers by depth, which determines the relative role of different PSE mechanisms. An analysis was conducted of different PSE mechanisms. The authors investigated PSE from M-centers of color and we showed their effect on PSE in the region of the F-absorption band. Author

N68-17995# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE EFFECT OF IONIZING RADIATION ON PHOTOSTIMULATED EMISSION FROM CRYSTALS NaCl AND KCl [VLIYANIYE IONIZIRUYUSHCHEGO IZLUCHENIYA NA FOTOSTIMULIROVANNUYU EMISSIYU S KRISTALLOV NaCl I KCl]

A. I. Belkind and R. I. Kalendarev *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 63–66 refs (See N68-17988 08-26)

The method of photostimulated emission is used to investigate the process of coloring natural and artificial NaCl and KCl crystals by ultraviolet light. The effect of preliminary X-raying on the coloring process is shown. Author

N68-17996# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMAL QUENCHING OF X-RAY LUMINESCENCE OF CERTAIN ALKALI HALIDE PHOSPHOR CRYSTALS [TEPLOVOYE TUSHENIYE RENTGENOLYUMINESTSENTSII NEKOTORYKH SHCHELOCHNOGALOIDNYKH KRISTALLOFOSFOROV]

K. K. Shvarts, E. D. Aluker, I. P. Mezina, and M. M. Grube *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 67–80 refs (See N68-17988 08-26)

The temperature dependence of stationary glow, flare-up of X-ray luminescence, and thermoluminescence of KCl–Tl, KBr–Tl, KI–Tl, and KI–In crystals are investigated in the interval of 100–700°K. Certain peculiarities of energy transfer by activator centers are discussed. Author

N68-17997# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

TEMPERATURE DEPENDENCE OF THE AMPLITUDE OF GAMMA SCINTILLATIONS IN CsI–Tl AND KI–Tl [TEMPERATURNAYA ZAVISIMOST' AMPLITUDY GAMMA-STSINTILLYATISIY V CsJ–Tl I KJ–Tl]

E. D. Aluker *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 81–83 refs (See N68-17988 08-26)

The dependence of the amplitude of gamma-scintillations in CsI–Tl and KI–Tl crystals upon temperature in the 293–473°K interval is measured. Author

N68-17998# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF ELECTRON PARAMAGNETIC RESONANCE AND LUMINESCENCE OF SOLID SOLUTIONS OF SODIUM AND MANGANESE CHLORIDE [ISSLEDOVANIYA ELEKTRONNOGO PARAMAGNITNOGO REZONANSA I LYUMINESTSENTSII TVERDYKH RASTVOROV KHLORISTOGO NATRIYA I MARGANTSA]

K. K. Shvarts, V. B. Layzan, and A. F. Lyushina *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 85–97 refs (See N68-17988 08-26)

Electron paramagnetic resonance, X-ray and sensitized luminescence spectra of NaCl $MnCl_2$ crystals are measured. The effect of Ca^{++}, Cd^{++} Pb^{++}, and F^- impurities on the paramagnetic and optical properties and disintegration of solid manganese solutions is investigated. Author

N68-17999# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ELECTRON PARAMAGNETIC RESONANCE OF MANGANESE IN NaCl CRYSTALS WITH CADMIUM AND CALCIUM IMPURITIES [ELEKTRONNYY PARAMAGNITNYY REZONANS MARGANTSA V KRISTALLAKH NaCl S PRIMESYAMI KADMIYA I KAL'TSIYA]

V. B. Layzan and A. Ya. Vitol *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 99–114 refs (See N68-17988 08-26)

Electron paramagnetic resonance spectra of Mn^{++} in NaCl crystals containing bivalent impurities were studied at frequencies ≈9 gigahertz. It was found that multiplets of fine structure which correspond to $Mn^{++}v_+$ associations are greatly reduced in hardened crystals with Cd^{++} and Ca^{++} impurities. These crystals have six strong hyperfine lines with $g=2.002\pm0.001$ and $A=(82.7\pm1)\times10^{-4}$ cm^{-1}. It is shown that the appearance of this multiplet is caused by the predominant localization of Mn^{++} ions in points with cubic symmetry. Author

N68-18000# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

KINETICS OF INTRACENTER LUMINESCENCE OF A KCl–Pb PHOSPHOR CRYSTAL [KINETIKA VNUTRITSENTROVOY LYUMINESTSENTSII KRISTALLOFOSFORA KCl–Pb]

M. F. Trinkler *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 115–125 refs (See N68-17988 08-26)

The kinetics of intracenter luminescence of a KCl–Pb phosphor crystal in the temperature range of 83–373°K was investigated by the method of oscillography of luminescence pulses. It was found that a luminescence pulse consists of two components: a long and a short. The temperature behavior of these components is compared with the theoretical expression for the intensity of a luminescence pulse when there are two closely located excited levels in the luminescence center. An attempt is made to more precisely define the mechanism of intracenter luminescence of KCl–Pb on the basis of the obtained results. Author

N68-18001# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF THE KINETICS OF INTRACENTER LUMINESCENCE IN A KCl–Tl CRYSTAL [ISSLEDOVANIYE KINETIKI VNUTRITSENTROVOY LYUMINESTSENTSII V KRISTALLE KCl–Tl]

A. K. Everte *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 127–140 refs (See N68-17988 08-26)

The time response and the excitation and luminescence spectra of a KCl–Tl phosphor crystal are investigated by means of oscillography of single luminescence pulses. A conclusion is drawn on the basis of the obtained results that the characteristic band of luminescence of a thallium ion (305 mμ) is not elementary, but consists of two close sub-bands. The probabilities of spontaneous transitions from triplet levels of a thallium ion for its various concentrations in KCl are determined by the Kravits formula. Author

N68-18002# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE KINETICS OF INTRACENTER LUMINESCENCE OF KBr–Tl [O KINETIKE VNUTRITSENTROVOY LYUMINESTSENTSII KBr–Tl]

I. K. Plyavin' and B. Ya. Berzin' *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 141–154 refs (See N68-17988 08-26)

The decay time, relative quantum yield, and emission spectra of activator luminescence of KBr–Tl are investigated by means of oscillography of separate photoscintillations. Certain characteristics of the thallium center are determined by comparing the experimental data with the theoretical calculations of B. I. Stepanov. An explanation of the mechanism of intracenter luminescence of KBr–Tl is given, which does not contradict the existing experimental data. Author

N68-18003# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF THE LUMINESCENCE OF A KI–Tl CRYSTAL. 1: EXCITATION IN AN ABSORPTION BAND THAT CORRESPONDS TO $^1S_0 \rightarrow {}^3P_1$ TRANSITIONS [ISSLEDOVANIYE LYUMINESTSENTSII KRISTALLA KJ–Tl. 1: VOZBUZHDENIYE V POLOSE POGLOSHCHENIYA, SOOTVETSTVUYUSHCHEY PEREKHODAM $^1S_0 \rightarrow {}^3P_1$]

B. Ya. Berzin' *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 155–166 refs (See N68-17988 08-26)

The kinetics of intracenter photoluminescence of a KI–Tl crystal was investigated by means of oscillography of single luminescence pulses. The crystal was excited in the 282 mμ absorption band and was investigated in the temperature interval from 80 to 300°K. It was found that in a KI–Tl crystal, similar to KCl–Pb, the luminescence pulses at low temperatures have a short and a long component. The intensities of both components were investigated, depending upon the wavelength of excitation emission at different crystal temperatures. The intensity of the short component and the decay time of the long component also were investigated, depending upon crystal temperature. When comparing the obtained experimental data with the calculation data, an attempt was made to determine the parameters of the luminescence center. Author

N68-18004# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF THE LUMINESCENCE OF A KI–Tl CRYSTAL. 2: EXCITATION IN AN ABSORPTION BAND THAT CORRESPONDS TO $^1S_0 \rightarrow ^3P_1$ TRANSITIONS [ISSLEDOVANIYE LYUMINESTSENTSII KRISTALLA KJ–Tl. 2: VOZBUZHDENIYE V POLOSE POGLOSHCHENIYA, SOOTVETSTVUYUSHCHEY PEREKHODAM $^1S_0 \rightarrow ^3P_1$
B. Ya. Berzin' *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 167–174 refs (See N68-17988 08-26)

The kinetics of luminescence of a KI–Tl crystal in a temperature interval from 80 to 300°K is investigated during excitation in the 233 mμ absorption band. The conclusion is made that the mechanism of activator luminescence and the parameters of the luminescence center are identical during excitation in the 233 and 282 mμ absorption bands. Author

N68-18005# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF THE LUMINESCENCE OF A KI–Tl CRYSTAL. 3: EXCITATION IN THE EXCITON ABSORPTION BAND [ISSLEDOVANIYE LYUMINESTSENTSII KRISTALLA KI–Tl. 3: VOZBUZHDENIYE V EKSITONNOY POLOSE POGLOSHCHENIYA]
B. Ya. Berzin' *In its* Radiation Phys. 1: Ion Crystals 5 Apr. 1967 p 175–177 refs (See N68-17988 08-26)

The kinetics of intracenter luminescence of a KI–Tl crystal is investigated in the 80–160°K temperature interval with excitation in the exciton absorption band. From a comparison with the results obtained in the case of intracenter excitation of a KI–Tl crystal there follows the assumption that exciton energy is transmitted chiefly to the lower excited level of the activator. Author

N68-18007# Illinois Univ., Urbana. Materials Research Lab.
MATERIALS SCIENCES RESEARCH Annual Technical Report, 1966–1967
1 Jan. 1968 167 p refs
(Contract ARPA SD-131)
(AD-663699)

Brief summaries are given of the status and results of ARPA and AEC supported research programs at the Univ. of Illinois Materials Research Laboratory in the areas cryogenics, crystallography, spectroscopy, metal physics, superconductivity, semiconductors, solid state physics and electronics, phase studies, high-pressure research, radiation damage, and related topics. A complete listing of published papers and theses is included. TAB

N68-18067*# National Bureau of Standards, Washington, D. C.
STANDARD MEASUREMENTS OF THE RESISTIVITY OF SILICON BY THE FOUR PROBE METHOD Final Report, 3 Apr.–30 Nov. 1967
W. Murray Bullis 29 Dec. 1967 93 p refs Sponsored by NASA
(Proj. ER-6576)
(NASA-CR-86032; NBS-9666) CFSTI: HC $3.00/MF $0.65 CSCL 20L

An improved standard procedure for measurement of circular silicon slices with four in-line point probes has been developed. Detailed analysis of a series of round-robin experiments showed that the procedure can attain a precision of ±2 per cent for interlaboratory comparisons of slices with room temperature resistivity between 0.005 and 120 ohm-cm. Resistivity non-uniformity in the test slices was shown to be a significant factor in limiting the precision which could be achieved. The importance of including correction factors for temperature, finite thickness, finite diameter, and unequal probe separations was demonstrated. Determination of the precision to be expected from the method in non-referee applications such as routine production and quality control will require additional study of such factors as surface conditions, probe force, current levels, etc. Author

N68-18116*# Techtran Corp., Glen Burnie, Md.
CALCULATING THE SURFACE ENERGY OF METALS WITH A BODY-CENTERED LATTICE [K RASCHETU POVERKHNOSTNOY ENERGII METALLOV S OTSK RESHETKOY]
Yu. S. Avraamov and A. G. Gvozdev Washington NASA Feb. 1968 6 p refs Transl. into ENGLISH from Fiz. Metal. i Metalloved. (USSR), v. 23, no. 3, 1967 p 405–408
(Contract NASw-1695)
(NASA-TT-F-11555) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The values are calculated for the surface energies and temperature coefficient of surface energy $d\sigma/dT$ in metals with a body-centered lattice for surfaces (100) (110) allowing for the effect of bonds with the second coordination sphere. Author

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N68-17259*# Union Carbide Plastics Co., Bound Brook, N. J. Polymer Research and Development Div.
SATURATED HYDROCARBON POLYMERIC BINDER FOR ADVANCED SOLID PROPELLANT AND HYBRID SOLID GRAIN, AUGUST 1–DECEMBER 31, 1967
James E. Potts, ed. 19 Jan. 1968 30 p Prepared for JPL
(Contracts NAS7-100; JPL-951210)
(NASA-CR-93172) CFSTI: HC $3.00/MF $0.65 CSCL 21I

Samples of ethylene/neohexene telomers were prepared by a batch process in the stirred autoclave reactor using bromoacid and bromoester telogens. From telomerization studies it was found that the bromoacid CTAC and the bromoester CTAD are the most useful telogens. The continuous stirred autoclave reactor was started. Reaction conditions and product goals were established, and are serving as reference points for telomer synthesis in the continuous reactor. Six runs were made in the continuous reactor using the bromoacid telogen CTAC. Telogen concentration and reactor residence times were varied and found to give useful and predictable control over the molecular weight without substantially affecting the functionality. Author

N68-17308# Weapons Research Establishment, Salisbury (Australia).
THE TURN OVER POINT METHOD FOR THE DETERMINATION OF THE END OF BURNING OF SOLID PROPELLANTS
B. E. Furby Aug. 1967 19 p refs
(WRE-TN-CP-137) CFSTI: HC $3.00/MF $0.65

A review is made of the common methods at present in use for the determination of the end of burning of solid propellant motors. The 'turn-over point' method, which is derived from events which are known to occur at the end of burning, is presented and, compared with the other methods, is found to have certain advantages, especially when sliver is present towards the end of burning. Author

N68-17309# Weapons Research Establishment, Salisbury (Australia).
THE BALLISTIC EVALUATION OF SOLID PROPELLANTS AT W.R.E.
B. E. Furby Aug. 1967 38 p refs
(WRE-TN-CPD-136) CFSTI: HC $3.00/MF $0.65

This paper describes the current equipment and techniques used for ballistic evaluation of solid propellants. The installation

was similar to a K-round firing facility. The reasons for modifications that have been made to the original installation are discussed. The present data handling system is based on Type 456 line telemetry and is almost completely automatic to the final results which are computed by the W.R.E. 7090 computer. Author

N68-17358*# Boeing Co., Seattle, Wash.
FUEL PRODUCED FROM SPACECRAFT MATERIAL
Howard M. Segal *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 93–98 refs (See N68-17350 08-30)

New areas of propellant synthesis are suggested and systems data supporting the suggestions are provided. These new areas involve the use of waste material in the vicinity of the spacecraft as a possible fuel ingredient and the development of unconventional methods for energizing material. Author

N68-17362*# Naval Ordnance Test Station, China Lake, Calif.
ROCKET PROPELLANTS FROM GEOTHERMAL EMISSIONS
R. D. Fulmer and G. W. Leonard *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 121–134 refs (See N68-17350 08-30)

There is a definite possibility that active volcanism may still exist on the moon. Possible compositions of lunar geothermal fluids are considered, and a standard composition was assumed for use in processing studies. This mixture consists of water (49 percent), carbon dioxide (41 percent), hydrogen chloride and hydrogen sulfide (3.5 percent each), and hydrogen and carbon monoxide (1.5 percent each). The performance of various rocket propellants that could be manufactured from these and several other geothermal gases was investigated. Four processes were chosen for more detailed study. These were: (1) hydrogen for nuclear rockets, (2) hydrogen and oxygen for chemical rockets and fuel cells, (3) methane and oxygen, and (4) methanol and oxygen. Flow charts were developed for the processes, and energy and mass flow requirements were given. Life support water, oxygen, and power were byproducts of each processing scheme. Technically, the feasibility of producing useful quantities of rocket propellants on the moon from geothermal emissions was established. Author

N68-17789# Naval Research Lab., Washington, D. C.
FLAMMABILITY PROPERTIES OF HYDROCARBON FUELS. PART 3: FLAMMABILITY PROPERTIES OF HYDROCARBON SOLUTIONS IN AIR Interim Report
Wilbur A. Affens 21 Nov. 1967 38 p refs
(NRL-6617, Pt. 3; AD-663881)

Previous work on the interrelations of the flammability properties of n-alkanes in air have been extended to both vapor and liquid fuel mixtures. Based on the application of Raoults and Daltons laws governing vapor pressure and composition above a solution of two or more liquid hydrocarbons to Le Chateliers rule governing the flammability limits of vapor mixtures, equations have been derived which make it possible to predict overall flammability properties of mixtures from the properties and proportions of the individual components. The flammability properties which were studied include: lower and upper flammability limits, heat of combustion, stoichiometric concentration, flash point, and flammability index (explosiveness). The derived equations demonstrate, quantitatively, why vapor pressure of individual constituents plays a more important role than concentration on the overall flammability properties of liquid hydrocarbon solutions, and that a very small amount of a highly volatile contaminant in a relatively nonflammable fuel may make it flammable. Author (TAB)

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N68-17269# Royal Aircraft Establishment, Farnborough (England).
VARIABLE GEOMETRY AIR INTAKES AT SUPERSONIC SPEEDS
E. L. Goldsmith Jun. 1966 36 p refs
(RAE-TR-66187)

The need for a variable geometry intake emanates in two ways; from the need to match engine and intake airflows and from the need to maintain high pressure recovery and low drag over a range of Mach numbers. These two requirements are examined briefly for all-external, all-internal and combined-compression intakes using the current supersonic transport aircraft as a main source of illustration. The aerodynamic advantages of a combined-compression intake becomes evident. Some small-scale tunnel tests were done at R.A.E. Bedford during 1960–61 on a model of a combined-compression intake at M=2.45. These tests have thrown some light on the problem of "unstarting" of the intake i.e. the difficulty of obtaining the desired internal shock pattern. They have also emphasised the significance of boundary layer bleed both on the compression surface and the sidewalls and the importance of achieving the right balance between internal and external compression. Author

N68-17288*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE OPERATION OF AN ELECTRON-BOMBARDMENT ION SOURCE WITH VARIOUS GASES
Paul D. Reader Washington 1964 14 p refs Presented at the Intern. Conf., Toronto, 5–7 May 1964 Sponsored by the Electrochem. Soc. and Am. Inst. of Mech. Engr.
(NASA-TM-X-52006) CFSTI: HC $3.00/MF $0.65 CSCL 21C

The efficiency of the electron-bombardment thrustor is approaching the maximum that can be expected. Desired lifetimes (of the order of 10,000 hr) have not yet been reached, but present knowledge indicates such lifetimes should be obtainable. The simplicity of this thrustor makes it interesting as an ion source for various laboratory experiments. Various gases were used to determine the ion-chamber and accelerator performance for such applications. Author

N68-17388# United Kingdom Atomic Energy Authority, Culham (England).
OPTIMISATION OF THE GIESSEN ION THRUSTOR
J. Freisinger and H. Loeb Oct. 1967 18 p refs Transl. into ENGLISH from Raumfahrtforsch. (Stuttgart), v. 10, no. 4, 1966 p 174–179
(CTO-423; NP-TR-1599) CFSTI: HC $3.00/MF $0.65

A mercury ion thrustor with a high-frequency ion source, which started operating during April 1964, was optimized between September 1964 and January 1966. By using small permanent magnets the discharge pressure could be decreased and a resonance-like increase in the power pickup of the discharge plasma was obtained. The ion extraction system was improved in the course of numerous series of tests. As a result of the optimization the original thrust was increased 5 times, the energy efficiency by 12%, the utilization efficiency by 5%, and the total efficiency by 15%. On completion of the tests, with an ion source volume of 0.5 lit the thrust was 1 p and the total efficiency 82.5%. Author (NSA)

N68-17401 Joint Publications Research Service, Washington, D. C.
HELICOPTER GAS TURBINE ENGINE
M. M. Maslennikov 24 Jan. 1968 112 p refs Transl. into ENGLISH from the Book "Vertoletnyye Gazoturbinnyye Dvigateli" Moscow, Mech. Eng. Press, 1966 p 5–35, 90–111, and 163–199 (JPRS-44128)

CONTENTS:

1. USE OF HEAT REGENERATION AND ELEVATED GAS TEMPERATURES IN HELICOPTER GAS TURBINE ENGINES A. F. Savostin and A. M. Tikhonov p 1–36 refs (See N68-17402 08-28)

2. SOME CHARACTERISTICS OF HELICOPTER POWERPLANTS WITH DIRECT TURBINE DRIVE OF MAIN ROTOR Yu. I. Dobryakov and A. F. Savostin p 37–62 refs (See N68-17403 08-28)

3. WEAR AND PERFORMANCE VARIATION OF AXIAL AND CENTRIFUGAL COMPRESSOR STAGES OPERATING IN DUSTY AIR Yu. I. Shal'man p 63–106 refs (See N68-17404 08-28)

N68-17402 Joint Publications Research Service, Washington, D. C.
USE OF HEAT REGENERATION AND ELEVATED GAS TEMPERATURES IN HELICOPTER GAS TURBINE ENGINES
A. F. Savostin and A. M. Tikhonov *In its* Helicopter Gas Turbine Engine 24 Jan. 1968 p 1–36 refs (See N68-17401 08-28)

An analytic investigation was conducted on possible helicopter engine performance with the use of heat regeneration and increased gas temperature at the turbine inlet. The calculations are based on high temperature engine and lightweight regenerator data, with consideration given to comparatively low-powered engines (600 to 1000 hp) for medium helicopters. Equations are derived to determine the variation of the size and weight characteristics as a function of the degree of regeneration. Thermodynamic calculations were made for three values of the gas temperature: 1200°, 1450°, and 1800°K. The results indicate: (1) The use of regeneration and increased turbine inlet gas temperature are effective for improving weight performance. (2) Most effective is the simultaneous use of the regenerator and increased gas temperature. For a moderate degree of regeneration (of the order of 0.6) and for a gas temperature acceptable with air cooling of the turbine (1400° to 1450°K), the fuel specific flow rate may be reduced by 27% to 28%, in comparison with its present level in the maximal power regime, and by 31% to 33% in the cruising regime, for the same engine weight. M.G.J.

N68-17403 Joint Publications Research Service, Washington, D. C.
SOME CHARACTERISTICS OF HELICOPTER POWERPLANTS WITH DIRECT TURBINE DRIVE OF MAIN ROTOR
Yu. I. Dobryakov and A. F. Savostin *In its* Helicopter Gas Turbine Engine 24 Jan. 1968 p 37–62 refs (See N68-17401 08-28)

In a detailed study of the properties and characteristics of power plants with low-speed turbines, particular consideration was given to the specific peculiarities of multistage low-speed turbines and the entire power plant, and to the operation of the turbine and power plant with emergency shutdown of one of the gas-producer engines. The results show: (1) Part-power operation of the power plant with a low-speed turbine has several peculiarities associated with the unusually strong influence of the rpm, and the available enthalpy differential of such a turbine on its efficiency and flow capacity. (2) The requirement to maintain 50% of the takeoff power with failure of one of the gas generator engines in the three-engine installation may be satisfied without any deterioration of the basic installation performance, but at the cost of some design complication. In the two-engine installation, this requirement leads to the necessity of using oversize engines with a resultant loss of economy and increase of installation weight. M.G.J.

N68-17404 Joint Publications Research Service, Washington, D. C.
WEAR AND PERFORMANCE VARIATION OF AXIAL AND CENTRIFUGAL COMPRESSOR STAGES OPERATING IN DUSTY AIR
Yu. I. Shal'man *In its* Helicopter Gas Turbine Engine 24 Jan. 1968 p 63–106 refs (See N68-17401 08-28)

To clarify the general pattern and basic laws governing the process of blade wear, studies were conducted with stationary cascades of profiles in an airflow containing dust particles of various sizes. Test conditions are described for determining the wear of axial compressor stage blades, and the erosion of centrifugal compressor components. The results show: (1) Entry of dust particles into the engine leads to wear of the individual engine components. The compressor rotors are subject to the most severe wear which reduces the engine service life. (2) Impact wear was observed in the blades of the axial stage, and the vanes of the rotating guide vanes and diffuser of the centrifugal compressor. Abrasion wear is characteristic of the impeller of the centrifugal stage. (3) The absolute magnitude of the wear is greater for larger dust particles, and is proportional to the particle impact velocity on the blade to about the 2.8 power for impact wear, and to the 2.0 power for abrasive wear. (4) Steel provides an average increase of about a factor of 2.8 in wear resistance in comparison to aluminum. M.G.J.

N68-17407*# Martin Co., Denver, Colo.
STERILIZABLE LIQUID PROPULSION SYSTEM Quarterly Progress Report, Oct. 1–Dec. 31, 1967
F. Brady and J. Keough Jan. 1968 72 p Prepared for JPL
(Contracts NAS7-100; JPL-951709)
(NASA-CR-93191; MCR-67-15; QPR-5) CFSTI: HC $3.00/MF $0.65 CSCL 21H

During this report period the module assembly was completed, propellants were loaded and the module was started into the decontamination and sterilization exposures. At the end of the period six cycles of ETO decontamination and four cycles of heat sterilization had been completed. At the completion of ETO testing, it was found that the nitrogen pressurant tank pressure had decayed from 1540 psig to 1120 psig due to a leak. The leak was found in a test instrumentation port cap. A repair was made and testing progressed without further problems. Author

N68-17431*# Atlantic Research Corp., Alexandria, Va.
STUDY OF PROPELLANT VALUE LEAKAGE IN A VACUUM Final Report, 7 Jun. 1965–15 Aug. 1966
Ralph D. Gift, John A. Simmons, Jack M. Spurlock, Joseph P. Copeland, and Jaydee M. Miller 28 Oct. 1966 247 p refs
(Contract NAS9-4494)
(NASA-CR-62046) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Results are presented of an investigation of the adverse effects of leakage through propellant valves into injector flow passages and combustion chambers, which are exposed to a vacuum environment. Leakage conditions were defined theoretically and confirmed experimentally. Experiments with nitrogen tetroxide and Aerozine-50 (1:1 mixture of hydrazine and UDMH), in a flow system simulating the propellant valve, manifold and injector plate of the Apollo Service Propulsion System engine, showed that blockages created by the freezing of leaking propellant in this system could stop the flow of propellant for periods of a few seconds to a few hours after the valve was opened. Similarly, shorter flow delays of a few to hundreds of milliseconds were caused by the freezing of leaked nitrogen tetroxide in the injector of a Gemini 25-pound thrust Reentry Control System engine. The fuel, monomethyl hydrazine, did not freeze evaporatively and block flow in the injector. It was demonstrated that one propellant could leak into the manifold of the other propellant, via the combustion chamber and injector ports, and cause an explosion in that manifold after the valves are opened to restart the engine. Author

N68-17556*# Northern Research and Engineering Corp., Cambridge, Mass.
COMPUTER PROGRAM FOR THE ANALYSIS OF ANNULAR COMBUSTORS. VOLUME 2: OPERATING MANUAL
Final Report
29 Jan. 1968 301 p refs
(Contract NAS3-9402)
(NASA-CR-72375; Rept.-1111-2, V. 2) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The Fortran listing is presented for a computer program developed to analyze aerodynamic and heat transfer characteristics in annular and rectangular gas turbines. The program is made up of the control, diffuser, airflow, and heat transfer subprograms, each of which has a family of subroutines. The purpose and content of each subroutine is discussed, and flow charts are given. The numerical techniques used are described, input and output procedures are outlined, and samples of library and test data are shown. A compilation of program messages, and a guide to the nomenclature are included. E.J.S.

N68-17557*# Northern Research and Engineering Corp., Cambridge, Mass.
COMPUTER PROGRAM FOR THE ANALYSIS OF ANNULAR COMBUSTORS. VOLUME 1: CALCULATION PROCEDURES
Final Report
29 Jan. 1968 246 p refs
(Contract NAS3-9402)
(NASA-CR-72374; Rept.-1111-1, V. 1) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The correlations and calculation methods used in developing a Fortran computer program for analyzing the aerodynamic and heat transfer characteristics of annular and rectangular gas turbine combustors are described, and the assumptions involved in applying them are discussed. A detailed presentation is given of the analytical methods used in the development of each of the three subprograms: (1) performance of the diffuser; (2) airflow, pressure, and temperature distribution in the flame tube and annuli, including calculation of the compressor total pressure loss; and (3) heat transfer and calculation of the flame-tube-wall temperature distribution. These subprograms were tested individually by comparing their predictions of appropriate quantities with experimental data from the open literature. Flow charts are included for each subprogram, as well as for the overall program. The complete system was tested by running a series of five hypothetical test cases using NASA specified geometries, inlet conditions, and program options. E.J.S.

N68-17669*# DANE Co., Ft. Collins, Colo.
PRELIMINARY DESIGN STUDY FOR THE ACCENT SYSTEM
Final Report, Mar. 2–Dec. 2, 1967
2 Dec. 1967 226 p
(Contract NAS5-10366)
(NASA-CR-93255; TR-002-1) CFSTI: HC $3.00/MF $0.65 CSCL 21C

Consideration is given to the basic physical processes, parametric analyses of system performance, recommended fabrication methods, and final electro-mechanical design of the complete system. Two electrogenerator designs are proposed for the ACCENT system, one with promethium-147 oxide fuel and the other with strontium-90 titanate fuel. Either of these electrogenerators could be integrated with either a cesium-contact ion thruster or with a charged-particle thruster. In the interests of economy, it is recommended that the prototype system be fueled with promethium-147 oxide, and be sized for a 10-micropound charged-particle thruster. Concurrently with the development of the promethium-147 prototype system, it is recommended that fabrication methods and flight-prototype designs be developed for electrogenerators of designs suitable for ACCENT systems with 20- to 350-micropound charged-particle thrusters. Author

N68-17941# Aerospace Corp., El Segundo, Calif.
PULSED PERFORMANCE OF A STEAM REACTION JET
H. Greer and D. J. Griep Jul. 1967 116 p refs
(Contract AF 04(695)-1001)
(TR-1001(2230-33)-2; SAMSO-TR-67-87; AD-663422)

The dynamic propulsive performance of a saturated steam reaction jet is analyzed and compared with the results of laboratory experiments. The vacuum thrust levels investigated range from 1 to 15 millipounds. The transient processes, which dominate the short-pulse or limit-cycle mode of thruster operation, are formulated and show good correlation with the data. The apparatus, procedures, and techniques required to obtain accurate test results for a low thrust, dynamic mode of operation are described. Impulse bit size, steam consumption, and specific impulse are characterized in terms of thruster geometry, gas properties, and command pulse width to provide a systematic basis for design. System limitations are discussed and design criteria necessary for successful spacecraft installation are provided. A comparison is made between the system performance of the steam reaction jet and the system performance of six different propellants. The results indicate that steam provides fairly high performance and may be attractive for certain spacecraft applications. Author (TAB)

N68-17987# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
AIRCRAFT ENGINE DESIGN
G. A. Kuz'min 9 Jun. 1967 421 p refs Transl. into ENGLISH from the book "Konstruktsiya Aviatsionnykh Dvigateley" Moscow, Oborongiz, 1962 p 1–443
(FTD-MT-64-402; AD-663929)

Contents: types and classification of gas turbine engines; axial compressors; centrifugal compressors; gas turbines; oscillation of buckets and disks; balancing gas-turbine engine rotors; rotor shafts and supports; critical number of rotor shaft revolutions; combustion chambers; exhaust assemblies and afterburners; turboprop reduction gears; drives for gas-turbine-engine assemblies; system of load-bearing housings of the gas-turbine engine; lubrication system of the gas-turbine engine; fuel system of the gas-turbine engine and its assemblies; adjusting the gas-turbine engine; ignition units of the gas-turbine engine; the kinematics and dynamics of the crankgear mechanism; balancing of piston engines; crankshafts; connecting rods; pistons; cylinders; gas distribution; reduction gears and blowers; casings and drives for the lubrication units and piston engine systems; piston-engine ignition system. TAB

N68-18066*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
PROPULSIVE POTENTIAL OF RESIDUAL ROCKET MOTOR HEAT
Joseph L. Ansell Feb. 1968 46 p refs
(NASA-TM-X-63124; X-470-68-46) CFSTI: HC $3.00/MF $0.65 CSCL 21H

This paper presents an analytical study on how to use the residual motor heat of a solid-propellant rocket for propulsion purposes in full vacuum, through the introduction of an inert quenching fluid. Three fluids were considered: water, propane, and Freon 12, with Delta Launch Vehicle third stage rocket motors (X-258 or FW-4). The possibility of using this quenching technique to provide fine velocity control was explored. Water was found to be superior to the other fluids under the conditions assumed, and the method appears to be feasible for velocity-trim within 6 minutes after solid-propellant burnout. The study includes a computer program to predict the effect of introducing the quenching fluid at various times subsequent to the peak motor temperature. Author

N68-18076* Purdue Univ., Lafayette, Ind. Jet Propulsion Center.
ACOUSTIC STANDING WAVES IN A ROCKET COMBUSTION CHAMBER WITH RING AND SPOKE BAFFLES

John W. Converse and Joe D. Hoffman Aug. 1967 180 p refs (Grant NsG-592)
(NASA-CR-93262; JPC-436; TM-67-5) CFSTI: $3.00 CSCL 21H

The phenomenon of acoustic wave propagation in rocket combustion chambers with ring-spoke baffles was investigated under the assumption that baffles "block" these waves near the injector. The eigenfunctions which define the space and time dependence of the standing waves peculiar to various cell geometries are discussed in this report, with particular emphasis on the radial functions and their eigenvalues. The behavior of transverse standing waves is illustrated by means of acoustic pressure contour maps. Superposition of standing waves is considered, and both "spinning" and aperiodic combinations are illustrated. The characteristic frequencies of the states are examined, and the possibility of a rational approach to baffle selection is suggested. The appendices include a tabulation of 500 transverse frequency eigenvalues and contour maps of the six lowest states in each of 24 cells. Experiments with an inexpensive slosh tank which may be used to demonstrate the behavior of transverse states are described. Author

N68-18126*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 7: LIQUID PROPELLANT ROCKET SYSTEMS
E. William Conrad Washington 1968 18 p Presented to Lewis Aerospace Explorers, Cleveland, 1966–1967
(NASA-TM-X-52394) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The major factors that govern the behavior of liquid propellant are discussed with emphasis on bipropellant rockets. The operating characteristics and design aspects are investigated in relation to the injector, combustion chamber, and exhaust nozzle. The problems associated with combustion instability are considered, and acoustic liners and baffles are two ways presented for controlling the instability. An assessment is made of the various cooling methods which are regenerative, ablative, transpiration dump, and radiation cooling. A brief description is given on the propellants for rocket propulsion and the reasons for their selection. Hypergolicity, temperature toxicity, cost and supply, and cooling capacity are some of the major factors evaluated in propellant selection. B.S.D.

N68-18136*# Hughes Research Labs., Malibu, Calif.
DISCHARGE CHAMBER STUDIES FOR MERCURY BOMBARDMENT ION THRUSTORS Semiannual Report
W. Knauer and P. Poeschel [1967] 60 p refs
(Contract NAS3-9703)
(NASA-CR-72350) CFSTI: HC $3.00/MF $0.65 CSCL 21C

Effects on the discharge properties of the magnetic field configuration, the cathode location and type, and the method of propellant introduction were studied in relation to mercury bombardment ion thrusters. Discharge diagnostic experiments include magnetic field variations and thruster performance, Langmuir probe measurements analysis, and Langmuir probe measurements in the thruster discharge. Plasma density across a discharge with diverging B-field is considerably more uniform than that with a homogeneous B-field, and the plasma potential was above anode potential for oxide cathode operation with both the homogeneous and diverging fields. The plasma electron temperature was determined at some points in the discharge where analysis of Langmuir probe data was possible. Optimization studies indicated that a strongly divergent field yields the best performance at 85% mass utilization, and for homogeneous and moderately divergent B-fields the customary cathode position on the axis in the rear is best. A cylindrical enclosure of the hollow cathode is necessary, a baffle alone is insufficient for good performance. M.W.R.

N68-18188*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COLD-AIR PERFORMANCE EVALUATION OF SCALE MODEL OXIDIZER PUMP-DRIVE TURBINE FOR THE M-1 HYDROGEN-OXYGEN ROCKET ENGINE. 4: PERFORMANCE OF FIRST STAGE WITH MODIFIED INLET FEEDPIPE-MANIFOLD ASSEMBLY
Roy G. Stabe and John F. Kline Washington Feb. 1968 24 p refs
(NASA-TN-D-4393) CFSTI: HC $3.00/MF $0.65 CSCL 21H

The aerodynamic performance of a 0.45 scale-model of the first stage of the oxygen pump-drive turbine for the M-1 rocket engine was determined experimentally. The first stage of the turbine was tested over a range of speeds and pressure ratios. The working fluid used in the investigation was dry air at inlet total conditions of 600°R (333°K) and approximately atmospheric pressure. Modification of the inlet manifold reduced the average feedpipe Mach number from 0.274 to 0.172. The smaller total pressure loss in the modified inlet manifold increased the nozzle inlet total pressure, the nozzle pressure ratio, and the equivalent weight flow. At first stage design equivalent speed and blade-jet speed ratio, the static efficiency was 0.39 and the total efficiency was 0.64 compared to 0.37 and 0.57 for the first stage with the unmodified manifold. The total efficiency of the first stage based on nozzle inlet, rather than manifold inlet, total pressure was 0.69 with the modified manifold compared to 0.67 with the unmodified manifold. An analysis of first-stage performance indicated that the rotor adiabatic efficiency increased from 0.81 with the unmodified inlet manifold to 0.84 with the modified inlet manifold. This improvement was attributed to the more uniform rotor inlet flow conditions afforded by the modified manifold. The nozzle adiabatic efficiency, however, was 0.94 for both cases. Author

N68-18216*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
COOLED BAFFLE DEVELOPMENT FOR M-1 ENGINE USING A SUBSCALE ROCKET ENGINE
E. William Conrad, John P. Wanhainen, and Jerome K. Curley Washington Oct. 1966 49 p refs (Declassified)
(NASA-TM-X-1267) CFSTI: HC $3.00/MF $0.65 CSCL 21H

A subscale rocket of 15,000 pounds thrust was used to provide a realistic environment for development of a suitable cooled baffle configuration for use in the M-1 engine development program. Chamber pressure, contraction ratio, mixture ratio, and injector elements were identical with the full-scale M-1 engine. Inasmuch as the size of an individual baffle compartment of the full-scale engine was approximated by the subscale engine, the heat transfer environment of the full-scale engine was also closely simulated. As a result of tests using a series of 25 baffles (segments of full scale) employing several cooling techniques, a configuration was developed that satisfied the design requirements and exhibited adequate durability. All baffle configurations employing transpiration cooling exhibited an unexpected multivalued flow characteristic curve, rendering these configurations unsuitable for use in the M-1 engine program. Author

N68-18221*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CHANGE IN INDUCER NET POSITIVE SUCTION HEAD REQUIREMENT WITH FLOW COEFFICIENT IN LOW TEMPERATURE HYDROGEN (27.9° TO 36.6°R)
Phillip R. Meng Washington Mar. 1968 28 p refs
(NASA-TN-D-4423) CFSTI: HC $3.00/MF $0.65 CSCL 21H

An 84° flat plate helical inducer was used to evaluate the thermodynamic effect of cavitation in low temperature liquid hydrogen over a range of flow coefficients. The range of liquid hydrogen temperatures studied was from 27.9° to 36.6°R. The tests were conducted at a rotative speed of 20 000 rpm over a range

of flow coefficients from 0.060 to 0.076 (1200 to 1500 gal/min). For a given head coefficient ratio, the required net positive suction head increased as the fluid inlet temperature was lowered. This decrease in inducer performance was attributed to a decrease in the thermodynamic effect of cavitation at the lower fluid temperatures. For a given temperature the thermodynamic effect of cavitation increased with decreasing flow coefficient. This effect is attributed to changes in blade pressure distribution with flow coefficient. The measured values of required net positive suction head are in reasonable agreement with those obtained using a semiempirical prediction method. Author

N68-18249*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL INVESTIGATION OF ACOUSTIC LINERS TO SUPPRESS SCREECH IN STORABLE PROPELLANT ROCKET MOTORS
David W. Vincent, Bert Phillips, and John P. Wanhainen Washington Mar. 1968 47 p refs
(NASA-TN-D-4442) CFSTI: HC $3.00/MF $0.65 CSCL 21H

Several acoustic liners (Helmholtz type) were experimentally and theoretically evaluated to determine their effectiveness to suppress screech in a rocket motor. The liners were experimentally rated in a storable propellant (N_2O_4-50 percent hydrazine, 50 percent UDMH) rocket at a nominal chamber pressure of 100 psia (689 kN/m^2) and 6700 pounds of thrust (29.8 kN). Liner design variables investigated included aperture size, liner percent open area, liner length, and aperture shape. Tests were conducted in both a marginally stable and a spontaneously unstable combustor. Bomb pulses were used to rate stability in terms of the grains (grams) of explosive necessary to induce instability. Bomb pulses as high as 170 psi (1172 kN/m^2) peak-to-peak were damped by liners when the liner resonant frequency was near the screech frequency. Calculated theoretical absorption coefficients assuming both flow and no flow past the apertures agreed with the experimental results. Full-length liners were not required for stabilization. Aperture size and shape had secondary effects. Longitudinal slots, which would be adaptable to regeneratively cooled configurations, were found to be as effective as circular apertures in suppressing screech. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N68-17291*# Oak Ridge National Lab., Tenn. Neutron Physics Div.
AN ESTIMATE OF THE PROMPT PHOTON SPECTRUM ARISING FROM COSMIC-RAY BOMBARDMENT OF THE MOON
T. W. Armstrong and R. G. Alsmiller, Jr. 4 Jan. 1968 19 p refs
(NASA Order R-104(1))
(NASA-CR-93150; ORNL-TM-2100) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Estimated was the photon leakage spectrum from the moon due to photons arising from the capture and inelastic scattering of neutrons produced by galactic cosmic rays. The method of calculation consisted of estimating the energy and spatial distribution of the neutron flux in the moon and then using Monte Carlo methods to obtain the photon source and to perform the photon transport. While the photon production and transport are carried out with some exactitude, the results must be considered very approximate because of the approximate neutron-flux distribution that is used. In particular, no attempt is made to account for the important effect which hydrogen in the lunar composition would have on the neutron flux distribution. Author

N68-17559# Lockheed Missiles and Space Co., Sunnyvale, Calif.
SPECTROMETRY OF SOFT X-RADIATION BY USING A GEIGER COUNTER
I. P. Tindo 1967 3 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, no. 5, 1967 p 796–797

A Geiger counter for use in the spectrometric analysis of soft X-rays is described in which the counter uses electrical regulation of the spectral response to analyze the composition of the radiation. The operating principle of the counter is based on the use of the acute dependence of the path of soft X-ray photons on the wavelength. The counter is the equivalent to a combination of the customary counter with three interchangeable gas filters. In contrast to the proportional counter in which the resolution drops with the increase in wavelength, the resolution of the Geiger counter remains approximately constant in the whole soft X-ray range. The results of some laboratory measurements with the counter are tabulated and discussed. R.N.A.

N68-17631# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).
COMPUTER PROGRAM FOR DECAY CALCULATIONS OF INTERNAL ARTIFICIAL RADIATION BELT (STARFISH) [PROGRAMME DE CALCUL DE DECROISSANCE DE LA CEINTURE ARTIFICIELLE INTERNE (STARFISH)]
J. Brettes Jul. 1967 10 p refs In FRENCH
(CERTS-01-3) CFSTI: HC $3.00/MF $0.65

A computer program is set up for the calculation of the decay of the artificial radiation belt developed by the Starfish explosion. ESRO

N68-17643# Centre d'Etudes et de Recherches en Technologie Spatiale, Toulouse (France).
EXPERIMENTAL DATA ON THE MAGNETOSPHERE AND SOLAR WIND [DONNEES EXPERIMENTALES SUR LA MAGNETOSPHERE ET LE VENT SOLAIRE]
J. C. Kosik Dec. 1967 136 p refs In FRENCH
(CERTS-NT-01-5) CFSTI: HC $3.00/MF $0.65

A state of the art is given of the present knowledge on the magnetosphere, solar systems, geomagnetism, electron belts, trapped particles, and solar wind. ESRO

N68-17935# Air Force Cambridge Research Labs., Bedford, Mass. Space Physics Lab.
THE GREAT BURST OF MAY 23, 1967
John P. Castelli, Jules Aarons, and Glen A. Michael (Air Weather Serv., Ent AFB, Colo.) Nov. 1967 20 p refs
(AFCRL-67-0622; AD-663445)

One of the largest radio bursts on record took place on May 23, 1967. Peak flux densities ranged between 23,000 flux units (10 to the minus 22nd power sq Wm/Hz) at 8800 MHz to about 370,000 units at 606 MHz. In addition to the high accuracy measurements of the peak flux densities at 606, 1415, 2695, 4995, and 8800 MHz, sweep frequency observations from 19 to 41 MHz show Type IV emission with Type II bursts occurring during the Type IV continuum. The associated flare was clearly visible in white light. In reviewing and compiling microwave radio data recorded during earlier white-light flares, it was found that all but one of eight events listed by Svestka (1966) had high microwave flux densities associated with them. In comparing radio burst intensity with optical flare importance for the series of three flares between 1809 and 2150 UT on May 23, 1967, there is only moderate agreement. The first radio burst was small; the second flare had the highest optical classification, while the third radio

burst was by far the largest. The flux densities of the third radio burst may have been the highest ever recorded in the decimeter portion of the radio spectrum and among the largest four in the 8800 MHz region. It is suggested that the details of the development of the flare be followed on radio flux density plots to determine detailed correlation with particle events in space and with terrestrial effects. Author (TAB)

N68-18027*# Volt Technical Corp., Washington, D. C.
REGISTRATION OF SOLAR COSMIC RAYS ON THE AMS "LUNA-11" [REGISTRATSIYA SOLNECHNYKH KOSMICHESKIKH LUCHEY NA ISL "LUNA-11"]
N. L. Grigorov, V. N. Lutsenko, V. L. Maduyev, N. F. Pisarenko, and I. A. Savenko 5 Mar. 1968 5 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, no. 6, 1967 p 946–948
(Contract NAS5-12487)
(NASA-CR-93231; ST-PF-SCR-10684) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Protons fluxes were measured on LUNA-11 during the late summer 1966 and their relationship with powerful solar flares is established. The results obtained are compared with those of AES "PROTON-3", making it possible to evaluate the spectrum of solar protons at time of measurement. Author

N68-18040# Aerospace Corp., El Segundo, Calif. Lab. Operations.
SOLAR X-RAY SPECTRUM BELOW 25 Å
Hugo R. Rugge and Arthur B. C. Walker, Jr. Oct. 1967 39 p refs
(Contract F04695-67-C-0158)
(TR-0158(9260-02)-1; SAMSO-TR-67-128; AD-663415)

A pulse-height analyzed proportional counter and a Bragg crystal spectrometer, both mounted on a compact solar pointer, were flown on the polar, earth-oriented satellite 1966-111B and obtained solar X-ray spectra below 25 A. The crystal spectrometer yielded one highly resolved spectrum from 7 to 25 A every 250 sec. Over the observed range, much of the X-ray energy is in line radiation. The predominant lines are those of the ions N VII, O VII, O VIII, FeXVII, NeIX, NeX, and MgXI. At least 50 emission lines were observed, a number of them for the first time. Spectra taken with the crystal spectrometer under various conditions of solar activity showed that large enhancements in flux are confined to the shorter wavelength lines. The proportional counter also showed a distinct hardening of the spectrum, as well as an increase in flux with solar activity. Author (TAB)

N68-18048*# Volt Technical Corp., Washington, D. C.
REGISTRATION OF ELECTRONS WITH ENERGIES > 30 KEV IN THE NEAR-LUNAR SPACE [REGISTRATSIYA V OKOLOLUNNOM PROSTRANSTVE ELEKTRONOV S ENEGIYEY VYSHE 30 KEV]
N. L. Grigorov, V. I. Lutsenko, V. L. Maduyev, N. F. Pisarenko, and I. A. Savenko 4 Mar. 1968 8 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, no. 6, 1967 p 891–896
(Contract NAS5-12487)
(NASA-CR-93286; ST-PF-IPS-10683) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Electron fluxes with energies higher than 30 kev were registered on the AES "LUNA-11". Description is given of the apparatus consisting of gas-discharge counters with magnetic filters and of a scintillation counter. The results of measurements of electron fluxes on 1 and 8 November 1966 are discussed. These measurements correspond to the period d ring which short-lived increases of electron intensity were revealed. Author

N68-18175*# Volt Technical Corp., Washington, D. C.
TAKING INTO ACCOUNT THE VERTICAL DRIFT OF MOLECULAR IONS WHEN DETERMINING THE KINETIC PARAMETERS OF IONIZATION–RECOMBINATION PROCESSES IN THE F_2-LAYER MAXIMUM [UCHET VERTIKAL'NOGO DREYFA MOLEKULYARNYKH IONOV PRI OPREDELENII KINETICHESKIKH PARAMETROV IONIZATSIONNO REKOMBINATSIONNYKH PROTSESSOV V MAKSIMUME SLOYA F_2]
N. N. Klimov and Yu. F. Solov'yev 4 Mar. 1968 3 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 8, no. 1, 1968 p 177–178
(Contract NAS5-12487)
(NASA-CR-93284; ST-AI-10679) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The kinetic parameters during the years of high solar activity were determined by assuming that only molecular ions are moving. The calculation was conducted in the assumption that near the main electron concentration maximum the molecular ions have a scale height equal to that of the neutral gas. Thus, the vertical drift of molecular ions due to neutral gas can be disregarded by taking into account the height distribution of the molecular ions. G.G.

N68-18182*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OBSERVATIONS OF TRAPPED ELECTRONS AT LOW AND HIGH ALTITUDES
D. J. Williams, J. F. Arens, and L. J. Lanzerotti (Bell Telephone Labs., Inc., Murray Hill, N. J.) Feb. 1968 79 p refs
(NASA-TM-X-63121; X-611-68-63) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Simultaneous data are presented for trapped electrons at energies ≥280 keV and ≥ MeV as observed throughout much of the outer zone at 1100 km by the satellite 1963 38C and in the near equatorial regions by the Explorer 26 satellite. The observations were obtained during the time period January 1 through June 29, 1965, for the L values 3.0, 3.5, 4.0, 4.5, 5.0, and 5.5 earth radii. A comparison is made of the time behavior of electrons mirroring near the magnetic equator and those mirroring at low altitudes. Results and conclusions concerning the behavior of the trapped electron intensities during five well defined magnetic storms which were accompanied by electron intensity increases throughout much of the region of observation are discussed. R.N.A.

N68-18191*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
RAPID INCREASES IN THE PROTON AND ELECTRON FLUXES IN THE MAGNETOSPHERE
Andrei Konradi Oct. 1967 31 p refs
(NASA-TM-X-63125; X-611-67-521) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Three rapid increases in the low energy electron and proton flux were observed on October 27, October 28, and December 1, 1961. The time histories of the intensities and spectra are presented. The close association between the events and the occurrence of polar sub-storms is shown. The similarity of the events and those of December 20, 1962 and April 15, 1965 is discussed. It is also shown that the October 28, 1961 event is consistent with adiabatic acceleration of particles during a storm sudden commencement. Author

N68-18251*# Pittsburgh Univ., Pa. Space Research Coordination Center.
COMMENTS ON THE EXCITATION OF THE GEOCORONAL H α NIGHTGLOW
T. M. Donahue 4 Jan. 1968 16 p refs
(Contract NASr-179; Grant NSF GP-4435)
(NASA-CR-93351; SRCC-66) CFSTI: HC $3.00/MF $0.65 CSCL 04A

It is pointed out that the excitation of geocoronal hydrogen at night by multiply scattered solar radiation occurs mainly at

thousands of kilometers above the earth's surface. The nature of the hydrogen distribution below about 400 km is of secondary importance in the transport mechanism and is weakly excited. For this reason Balmer α excitation by Lyman β scattering can be predicted without serious error even if the large gradient in hydrogen density near 100 km is ignored. An approximate calculation involving plane parallel geometry shows that during solar minimum the expected nightglow Balmer α brightness has approximately the measured value of 2 Rayleighs. Author

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N68-17235*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

AN INVESTIGATION OF A GRAY, OPTICALLY THICK PLANETARY ATMOSPHERE IN CONVECTIVE-RADIATIVE EQUILIBRIUM

Richard B. Wattson (Princeton Univ.) [1967] 27 p refs Sponsored by ONR

(Grants NGR-09-015-023; NsG-69; NSF GP-579)

(NASA-CR-93162) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Optically thick planetary atmospheres in radiative–convective equilibrium have been investigated by the use of models which have an adiabatic temperature gradient in the troposphere. The gray stratospheric solution employs the discrete ordinate method to match correctly the tropopause boundary condition in which the tropopause location is found by temperature continuity. The models show that convection may increase the surface gray infrared opacity requirements by as much as an order of magnitude in greenhouse type theories as applied, for example, to Venus. A more approximate, analytical solution is also presented which generally agrees with the more elaborate treatment quite well. One of the major differences between the two types of solutions is the temperature gradient discontinuity at the tropopause predicted by the more exact theory. Author

N68-17252*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

NUCLEAR CHARGE SPECTRA AND ENERGY SPECTRA IN THE SEPTEMBER 2, 1966 SOLAR PARTICLE EVENT

N. Durgaprasad, C. E. Fichtel, D. E. Guss, and D. V. Reames Feb. 1968 29 p refs

(NASA-TM-X-63111; X-611-68-55) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Heavy nuclei ($Z \geq 3$) were detected in the September 2, 1966 solar particle event. The proton energy spectrum was measured down to energies as low as 3 MeV and up to energies as high as 100 MeV, with measurements on the helium and heavier nuclei covering a more restricted range. The relative abundances of helium, light, medium, and heavy nuclei obtained in this experiment in the energy range from about 14 to 35 MV nucleon agree with those measured in previous solar particle events at higher energies and hence with those of the solar photosphere. This result strengthens the concept of a multicharged nuclear composition which is a characteristic of solar particle events. The proton spectrum agrees with an exponential rigidity spectrum above 250 MV, but shows sharp deviations below 250 MV early in the event. An examination of the relative abundances of protons and medium nuclei shows that the propagation of solar particles in this event cannot be described by a simple diffusion model with a diffusion coefficient proportional to β or βR. Author

N68-17273# Royal Aircraft Establishment, Farnborough (England).

THE ORBIT OF COSMOS 42 ROCKET (1964-50B)

R. H. Gooding and T. M. Weight Jul. 1966 17 p refs

(RAE-TR-66210)

Six sets of orbital parameters have been computed from 93 visual observations of Cosmos 42 rocket in 1965. They are used to make estimates of atmospheric density at a height of 240 km, results consistent with those from other Cosmos rockets being obtained. Residuals in the orbit determinations indicate that the average accuracy of the observations, including the effect of timing errors, is about 5 minutes of arc. Author

N68-17297# Texas Univ., Austin. Dept. of Astronomy.

SPECTROSCOPIC AND RADIAL VELOCITY SURVEY OF BRIGHT GALAXIES Final Report, Dec. 1, 1965–Nov. 30, 1967

Gerard de Vaucouleurs and Antoinette de Vaucouleurs Dec. 1967 9 p refs

(Contract N00014-66-C-0061)

(AD-662468)

Redshifts of 113 bright galaxies including 94 new determinations are listed from 159 spectrograms obtained between 1960 and 1966 with the prime-focus B spectrograph of the McDonald Observatory 82-in. reflector (dispersion 330 A/mm at H alpha). The mean error for unit weight is sigma sub 1 = plus or minus 90 km/sec and plate weights range from 0.5 to 40. Comparison of multiple observations for the same galaxy and with previously published values confirms the weighting system and the absence of systematic errors. Author (TAB)

N68-17311# Weapons Research Establishment, Salisbury (Australia).

THE PREDICTION OF JUPITER'S DECAMETRIC EMISSION

D. G. Singleton May 1967 30 p refs

(WRE-TN-APD-10) CFSTI: HC $3.00/MF $0.65

It is shown that it is possible to predict the decametric radio emission of the planet Jupiter with the aid of a probability distribution of emission which depends jointly on the longitude of the central meridian of Jupiter, as viewed from the earth, and the orbital position of the Jovian satellite Io. The only experimentally determined joint probability distribution available, while based on all emissions in the frequency range 7.6 to 41 Mc/s, is nevertheless found to be heavily biased in favor of the behavior of the vicinity of 20 Mc/s. Consequently, the predictions obtained are most reliable in the vicinity of 20 Mc/s. A computer program is described which implements the prediction scheme. Author

N68-17330# Chile Univ., Santiago. Facultad de Sciencias Fisicas y Matematicas.

RESULTS OF OBSERVATIONS MADE WITH THE DANJON ASTROLABE AT SANTIAGO, 1965–1966

K. Czuia, P. Guerra, and F. Noel 1966 16 p refs *Its* Publ. No. 3

The publication includes the results in time, latitude, and zenith distance obtained with the Danjon Astrolabe at the Observatorio Astronomico Nacional at Cerro Calan (Santiago). A brief description of the program and the installation is given as well as the list of the stars groups. Author

N68-17350*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

FIFTH ANNUAL MEETING. WORKING GROUP ON EXTRATERRESTRIAL RESOURCES

Washington 3 Mar. 1967 239 p refs Meeting held 1–3 Mar. 1967

(NASA-TM-X-60870) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The feasibility of using extraterrestrial resources to reduce the dependence of lunar and planetary exploration on terrestrial

supplies is discussed, with consideration given to logistics requirements, mining and processing, and biotechnology. For individual titles, see N68-17351 through N68-17371.

N68-17351*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FUTURE TRENDS IN ORBITAL EXPLORATIONS
Wernher von Braun *In its* 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 1–4 (See N68-17350 08-30)

The Apollo Applications Program, considered to be the second significant step toward a manned lunar landing, is described briefly, and its experiments are discussed. The program elements, selected for greatest contribution at lowest cost, are outlined. Emphasis is placed on the Apollo telescope mount with its high resolution X-ray telescope and on the orbital workshop and its biological and medical experiments. N.E.N.

N68-17352*# Martin Co., Denver, Colo.
ACCELERATING EXPLOITATION OF EXTRATERRESTRIAL RESOURCES
George W. Morganthaler *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 5–14 refs (See N68-17350 08-30)

Past efforts of the Working Group on Extraterrestrial Resources are classified, and suggestions for wider use of the resources are discussed. Detection and search of resources, emp.. ısizing the time required, and the use of information theory in handling coded data are described. Prototype instruments and equipment for lunar and planetary exploration are studied. Possible applications of extraterrestrial resources are indicated for orbital communication centers, earth survey orbital systems, production of microelectronics and pharmaceuticals in super-clean orbital environment, tourism and medical research orbital systems, and application to new scientific missions. N.E.N.

N68-17353*# General Electric Co., Philadelphia, Pa.
UTILIZATION OF CRATER REFLECTORS FOR LUNAR RADIO ASTRONOMY
John M. Greiner *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 15–43 refs (See N68-17350 08-30)

The feasibility of using lunar craters as low frequency reflectors with high resolution and reduced interference levels is investigated. The analysis and evaluation of symmetric parabolic craters is emphasized, and techniques for using lunar craters in radio astronomy are suggested. The most desirable operating frequencies, resolution, and locations are considered, and the surface and subsurface characteristics, especially electromagnetic properties, and are discussed. The theoretical effective aperture and aperture power distribution are calculated, and several actual craters are identified. It is concluded that the reflector system would have the following advantages: minimal dependence upon environmental unknowns, immediate exploitation of lunar surface radio astronomy, favorable capabilities with respect to advanced systems, and utilization of unique lunar features. The problem areas are identified as radiation intensity, lunar ionosphere, surface irregularities and inhomogeneities, and, particularly, focal feed antenna placement. N.E.N.

N68-17354*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OBSERVATIONS OF CHANGES ON THE MOON
Winifred Sawtell Cameron *In its* 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 47–56 refs (See N68-17350 08-30)

Changes in the lunar features are discussed, emphasizing those of Aristarchus. It was found that there is a relation to the maria, and a majority of the anomalies are considered to imply internal activity. Current hypotheses are discussed, and include a sunrise or low angle illumination effect, a tidal effect, and a magnetic tail effect. It was determined that about twice as many phenomena were observed near sunrise as would be statistically expected, and about 1.5 to 2 times the expected number fall within the earth's magnetic tail boundaries. It is tentatively concluded that (1) there may be a reaction of surface materials and/or gases to the first rays of sunlight, and (2) there may also be an interaction of lunar materials with solar particles that have interacted with the earth's magnetic tail. N.E.N.

N68-17355*# National Aeronautics and Space Administration, Washington, D. C.
THE ANTARCTIC ANALOGY FOR LUNAR EXPLORATION
Rodney W. Johnson *In its* 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 61–73 refs (See N68-17350 08-30)

The relationship between the exploration of Antarctica and the proposed program of exploration of the moon is considered. The discussion centers on comparison of the environment, scientific missions and the role of man in exploration. Particular emphasis is placed on evaluation of the capability of man in extreme environments to participate in and support the mission objectives. Specific operational elements of locomotion, shelter, logistics and construction techniques are discussed in some detail for both Antarctica and the moon. The importance of operational capability and flexibility in assuring the success of the scientific mission is shown to be a vital element of exploration programs. A number of tables summarizing reference data are included; several conclusions derived from the analysis are presented. Author

N68-17356*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
UTILIZATION OF PLANETARY ATMOSPHERES FOR POWER AND PROPULSION OPERATIONS
Donald L. Young and Duane F. Dipprey *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 75–83 refs (See N68-17350 08-30) (Contract NAS7-100)

The possibility of utilizing Mars and Venus atmospheres as sources of chemical energy is investigated. Carbon dioxide and nitrogen are considered to be the major constituents of the atmospheres, and the energy obtainable from burning beryllium powder in the gases is calculated. Using these gases as oxidizer and working fluid in a gas turbine is discussed for producing power for ground operations or thrust for aircraft flight. It is concluded that the air breathing, open Brayton cycle systems promise large reductions in mass launched from earth when compared with other chemical power systems, and are competitive with nuclear systems for operation of a few weeks' duration. The conversion of the atmospheres to liquified oxidizers for rocket engines of vehicles leaving the planet is also considered. It is concluded that the propellant production does not yield sufficient mass savings to warrant the complexities involved. N.E.N.

N68-17357*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE CONTRIBUTION OF LUNAR RESOURCE PRODUCTION TO A PROGRAM OF LUNAR EXPLORATION AND SCIENCE
David Paul, III *In its* 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 85–91 refs (See N68-17350 08-30)

Expendable requirements associated with a projected program of lunar science and exploration are identified and analyzed for compatibility with the utilization of lunar resource production. A

possible production scheme is suggested and its economic justification assessed. The marginal economies realized as a result of the many favorable assumptions on which this analysis is based, and the sensitivity of the economics to the optimism of the estimates lead to the suggestion that currently envisioned programs of lunar science and exploration cannot be expected to utilize lunar resource production effectively. Author

N68-17359*# Martin Co., Denver, Colo.
DECISION THEORY AND PLANNING OF EXTRATERRESTRIAL RESOURCE UTILIZATION
Robert S. Novosad *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 99–106 refs (See N68-17350 08-30)

The formulation of a resource utilization program is examined within the logical framework provided by decision theory. Possible developments leading to post-2000 missions are outlined, and the utility function is discussed in terms of cost. The application of the approach to the Venus mission is described in detail. Justification of current studies of extraterrestrial resources is placed in the context of long-term series decisions on space developments, and the utility of potential experimental projects is considered. N.E.N.

N68-17360*# National Aeronautics and Space Administration, Washington, D. C.
IMPLICATIONS OF USE OF LUNAR PROPELLANTS IN SPACE TRANSPORTATION SYSTEMS
J. A. Salmanson *In its* 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 107–116 refs (See N68-17350 08-30)

A simplified analysis, using the rocket equation, is made on typical space stages representing S–II, S–IVB and Centaur stages in size, operating from orbiting terminals around the earth and moon. The terminals are logistically supported by reusable surface to orbit vehicles. Payload fractions for several mission altitudes and mission modes are determined and compared. The cost of a hypothetical planetary program, logistically supported from earth, is estimated. From this estimate, a reference or break-even cost for lunar propellant production is established. Operation below the break-even point could result in substantially reduced program costs were logistic support to originate from the moon. The results should serve as a guide for improved models of lunar mining and processing and system synthesis in support of space transportation. Author

N68-17361*# Naval Ordnance Test Station, China Lake, Calif.
LUNAR GRAVITY AS A POWER SOURCE
J. Kenneth Pringle *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 117–119 refs (See N68-17350 08-30)

The transportation of material from a higher elevation to a lower one is investigated as a source of power. The advantages and disadvantages are discussed for the main methods of gravity utilization: tramways which transport rocky material from an elevated place of working to a lower dump area; pipelines with rock suspensions in fluids systems; fluids systems in connection with solar radiation. It is considered that the tramlines offer the greatest advantages on the basis of efficiency, maintenance, small number of moving parts, and flexibility in complexity. N.E.N.

N68-17364*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SURFACE MINING ON THE MOON
H. M. Weathers, S. A. Fields, R. M. Cox, and R. O. Shotts (Ala. Univ.) *In its* 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 161–180 refs (See N68-17350 08-30)

The two largest uncertainties in determining the feasibility of mining are the availability of quantities of desirable native materials for the production of fuel components and water, and the magnitude of the space program. The vacuum environment is shown to have a pronounced effect upon porosity, bearing strength, adhesion, and the frictional characteristics of simulated lunar surface materials. Studies were made of several surface mining methods which could be adapted for use on the moon, considering the requirements for power, manpower, ore production, crew safety, weight and delivery costs, simplicity of operation, and mine operations. The preliminary studies indicate that surface mining may be advantageous if the space program becomes large enough to require extensive lunar exploration or planetary exploration from a lunar base or colony. Author

N68-17365*# Northrop Corp., Hawthorne, Calif.
TERRESTRIAL BY-PRODUCTS OF LUNAR ORIENTED RESEARCH IN EXPERIMENTAL PETROLOGY
E. Azmon *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 181–186 refs (See N68-17350 08-30)

Complex rock materials under extreme pressures and temperatures were studied. The technique and skill for handling and analysis of complex materials were developed. The prime purpose of the study was to develop the basic knowledge needed for beneficial use of lunar rocks. Several results establish a better understanding of complex solids in three fields of terrestrial interests: (1) materials, or complex metal oxides; (2) high speed transportation, or reentry temperature systems; and (3) geophysics, or elastic wave propagation through rock media at elevated temperature and pressure. Each one of these fields is discussed briefly in an attempt to show the way in which the lunar study has yielded terrestrial by-products of significance. Author

N68-17368*# Minneapolis-Honeywell Regulator Co., Minn.
LUNEX 2: A SIMULATED EIGHTEEN DAY MANNED LUNAR MISSION
Neal M. Burns, Haydon Y. Grubbs, and John E. Haaland *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 199–205 refs (See N68-17350 08-30)

The simulated lunar mobile laboratory and the tasks performed by the two-man crew are described. Shirt-sleeve, ventilated, and pressurized suit conditions were evaluated in the context of simulated normal and emergency activities. The tasks performed include driving, monitoring, navigation, audio balancing, sample measurement, and geophysical tasks. Crew performance was evaluated, and physiological measurements were also obtained. It was demonstrated that careful workspace layouts can make a small vehicle habitable and functional. N.E.N.

N68-17371*# Geological Survey, Washington, D. C.
METHODS TESTING FOR GEOLOGIC EXPLORATION OF MOON
Kenna V. Edmonds *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 223 ref (See N68-17350 08-30)

A film is briefly described which illustrates a scientific mission type of control center for early Apollo field investigations. The problem of how to get geologic information from the surface of the moon to the earth in real time is studied as well as obtaining samples. N.E.N.

N68-17375# Lockheed Missiles and Space Co., Sunnyvale, Calif.
DERIVATION OF FINAL FORMULAS TO DETERMINE SATELLITE LIFETIME

M. K. Tikhonravov, I. M. Iatsunskii, G. Iu. Maksimov, I. K. Bazhinov, and O. V. Gurko 1967 7 p Transl. into ENGLISH from the Book "Principles of Flight Theory and Projection Elements of Satellites" Moscow, Mashinostr., 1967 p 167–175

As direct integration of equations for certain orbit elements is not possible due to their complexity, certain additional simplifications are proposed. These are based on dividing the whole range of possible orbits into two groups: orbits with high eccentricities, and orbits with low eccentricities. Author

N68-17480# Defence Research Board, Ottawa (Ontario).
A TWO-LAYER MODEL FOR THE ATMOSPHERE OF VENUS
Yu. N. Vetukhnovskaya and A. D. Kuz'min Jan. 1968 5 p refs Transl. into ENGLISH from Astron. Vestn., v. 1, no. 2, 1967 p 85–88
(T-492-R)

A two-layer model of the Venerian atmosphere is considered, which satisfies the data of both radio-astronomical and radar observations, including the measurements in the 3-cm waveband that exhibited a decrease of the effective reflection cross-section of Venus. Author

N68-17527# Joint Publications Research Service, Washington, D. C.
ASTRONOMY
In its Soviet-Bloc Res. in Geophys., Astronomy, and Space, No. 173 2 Feb. 1968 p 1–10 refs (See N68-17526 08-13)

Abstracted data and news briefs are presented on research in astronomy. Geological maps of the visible side of the moon and maps from photographs of the far side are described. Recent investigations are reported on solar radiations, solar flares, radio emission and solar wind from solar flares, and element abundance in the sun. Astronomical instruments, measurements, and inertial coordinate system are also mentioned. N.E.N.

N68-17543# Lockheed Missiles and Space Co., Sunnyvale, Calif.
ESTIMATION OF THE ACCURACY OF LANDING
M. K. Tikhonravov, I. M. Iatsunskii, G. Iu. Maksimov, I. K. Bazhinov, and O. V. Gurko 1967 6 p Transl. into ENGLISH from the book "Principles of the Theory of Flight and Elements of Projections of Artificial Earth Satellites" Moscow, Mashinostr., 1967 p 74–81

Consideration is given to the problem of a space vehicle's deviation from a given landing site because of errors in the communicated additional velocity. The error in communication of the additional velocity is characterized by deviations in the magnitude of the additional velocity, by deviations of the angle of the direction of the additional velocity vector, and by the velocity component on the normal to the orbital plane. It is assumed that the exact orbit is known. The errors cause deviations in the dropping point from the designated point in the orbit plane and in the direction perpendicular to the orbit plane. The effects of the earth's rotation on the landing accuracy and the influence of the atmosphere on the descent trajectory are neglected. Errors on the portions of flight in the dense layers of the atmosphere are considered separately. R.N.A.

N68-17589*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
ENVIRONMENTAL PRESSURES ON SATELLITES
1 Aug. 1967 58 p refs
(Contract NAS8-21043)
(NASA-CR-61582; DOC.-67SD289) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The equations and logic used for the digital computer simulation of environmental pressure effects on an earth-orbiting satellite are presented. Although they were derived for use with the flexible body structural dynamical simulation, they are equally applicable to any combination of rigid, articulated, and flexible bodies. The pressure analyses include solar radiation, aerodynamic, and earth's albedo pressures. These effects involve a pressure due to exchange of momentum between the satellite and an incident flux of particles or photons. The mathematical models for their effects are therefore analogous, and the same equations can be used for force and torque in each analysis. This simplifies the engineering analysis, programming, and checkout of the program. The scheme for combining the simulation of the three effects is explained. The inclusion of any effect in a particular computer run is an option of the user. For each of the effects, the computations peculiar to that effect are performed first. Then a common set of equations and logic is used for shadow geometry, forces, and torques. Author

N68-17598 Joint Publications Research Service, Washington, D. C.
ASTRONOMY
In its Soviet-Bloc Res. in Geophys., Astron., and Space, No. 174 19 Feb. 1968 p 1–20 (See N68-17597 08-13)

Astronomical researches in celestial mechanics, planetary sciences, and solar studies are summarized. The areas of investigations include the following: solar atmosphere, disk, flares, radiation radio emission, and eclipse; planets Pluto and Mercury; star clusters; mathematical models of three body systems; meteors; and instrument development. N.E.N.

N68-17672# Aerospace Corp., El Segundo, Calif. Technical Operations.
OPTIMUM THREE-DIMENSIONAL DEORBIT FOR SPECIFIC REENTRY ANGLE FROM CIRCULAR ORBITS
S. T. Chu Oct. 1967 53 p refs
(Contract F04695-67-C-0158)
(TR-0158(3520-60)-1; SAMSO-TR-67-117; AD-663710)

The minimum impulsive velocity requirements for three-dimensional deorbits from circular orbits to achieve any specified reentry angle are analyzed. The investigation treats two cases: the first case determines the optimum impulsive velocity for a given reentry angle and a given heading angle change; the second treats the problem of a given reentry angle and a given earth central cross-range angle. Comparisons are made between a solution based on superposition and the analytical optimum solution developed for the case of constant heading change. The method of superposition treats separately the velocity required for in-plane deorbit and the velocity required for heading change. The results are summed algebraically or vectorially to give the combined velocity requirement. It is shown that large savings may be realized by combining the deorbit impulse and the impulse necessary to change the heading angle. Moreover, the three-dimensional optimum solution may be approximated very closely by superposition provided that the corresponding two-dimensional optimum solution is used and that it is summed vectorially with correct angular relation to the out-of-plane velocity component. Finally, the parametric results of the optimum solutions for deorbit from altitudes of 75, 100, 200, and 300 n mi and reentry angles between -1 and -25 deg are presented. TAB

N68-17698*# TRW Systems Group, Redondo Beach, Calif.
RESONANT SATELLITE GEODESY STUDY Final Report
B. C. Douglas and Michael T. Palmiter [1967] 88 p refs
(Contract NAS5-10469)
(NASA-CR-93245; TRW-09128-6001-R000) CFSTI: HC $3.00/MF $0.65 CSCL 22C

Quantitative estimates of the relative usefulness of resonant and nonresonant satellite orbits for determining geopotential constants were determined, and the resonant orbits were found to be far more useful by comparing covariance matrices of the unknown geopotential constants from simulated observations of both types of

orbits. Eccentric resonant orbits yielded about two or three times more constants per orbit than circular or nearly circular orbits. Injection velocity errors of 20 ft/sec do not seriously degrade the accuracy of the determination, and the problem of separating the effects of the constants from each other is less critical for the resonant orbits than those that are nonresonant. Inclinations of 50 or more are the only useful ones for constants in the range of (8,8) to (15,15). M.W.R.

N68-17778# RAND Corp., Santa Monica, Calif.
THE RADIATION FROM METEORS AND BOLIDES [IZLUCHENIE METEOROV I BOLIDOV]
V. A. Bronshten and K. A. Liubarsky Feb. 1968 51 p refs Transl. into ENGLISH from Meteornaia Materiia v Atm. Zemli (Moscow), 1966 p 3–29
(P-3779) CFSTI: HC $3.00/MF $0.65

When meteoric bodies traveling at cosmic velocities enter the earth's atmosphere, their interaction with air molecules and atoms results in a series of phenomena which are of interest not only to astronomers but also to physicists. In the case of a meteoric body of sufficiently large dimensions, a detached shock wave is produced in front of it and dissociation of air molecules and ionization of atoms also occur in the shock and initiate a heavy flux of radiation. In the present survey the authors' goal is to deal with the contemporary state of the problem of radiation from bright meteors and bolides, its nature and composition (to which spectroscopic methods of study are applied), and also to conduct a theoretical analysis of the problem of radiation from shock waves formed by large meteoric bodies. Author

N68-17791*# RAND Corp., Santa Monica, Calif.
NUMERICAL SIMULATION OF THE GENERAL ATMOSPHERIC CIRCULATION AND CLIMATE ON MARS
Final Report
C. B. Leovy and Y. Mintz Jan. 1968 88 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951943)
(NASA-CR-93196; AR-362-JPL) CFSTI: HC $3.00/MF $0.65
CSCL 03B

The two-level primitive-equation model developed by Mintz and Arakawa has been adapted to simulate the atmospheric circulation and the climate of Mars. The model incorporates heating and cooling of the atmosphere by solar radiation, infrared radiative transfer and turbulent convection. Carbon dioxide is the principal atmospheric constituent; it condenses on the planet's surface, releasing latent heat, when the surface cools to the CO_2 frost point. Two numerical integration experiments are made; one simulates orbital conditions at the southern summer solstice, the other orbital conditions at the southern autumnal equinox of Mars. The results for the solstice experiment show an intense meridional circulation across the equator and a strong west-wind maximum in the winter hemisphere, which is maintained by mass inflow toward a condensing CO_2 polar cap. The equinox experiment is more like that of the earth's atmosphere, with westerly winds in the middle latitudes of both hemispheres, and easterlies in the tropics and near the poles. In both experiments there are active baroclinic disturbances in the regions of strong temperature gradients. Author

N68-17841# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
THE MATRIZANTS OF THE KEPLERIAN MOTIONS (THE TWO-DIMENSIONAL CASE)
Andre Deprit Oct. 1967 42 p refs *Its* Math. Note No. 537
(D1-82-0663; AD-663679)

The variational equations of the problem of two bodies have been solved from first principles applying Jacobis dual theorem to the last multiplier to the adjoint of the Hamiltonian system expressed in Cartesian coordinates with respect to an arbitrarily given inertial frame of reference. Once the matrizant R(t;t0) in that system has been obtained in closed form, other forms of the resolvent are derived simply by homogeneous canonical extensions. By way of illustration, we have recovered in this way the matrizants in the orbital frame of reference and in Hills intrinsic coordinate system. TAB

N68-17845*# National Aeronautics and Space Administration, Washington, D. C.
PRINCIPAL SCIENTIFIC RESULTS
L. D. Jaffe, S. A. Batterson, W. E. Brown, Jr., E. M. Christensen, S. E. Dwornik et al *In its* Surveyor 5 Dec. 1967 p 1–2 (See N68-17844 08-31)

An overview is presented on the Surveyor 5 measurements of the lunar surface composition; the gross chemical composition data were obtained by an alpha-particle backscattering instrument, and the magnetic characteristics of the surface material were obtained by a bar magnet positioned on a landing pad. Among the data reported are: (1) The three most abundant elements found at the mare landing site are oxygen, silicon, and aluminum. The relative amounts of the chemical elements are similar to those of a silicate rock of a basaltic type. (2) The quantity of magnetic material observed on the magnet is comparable to that expected if the magnet came in contact with pulverized basalt with 10% to 12% magnetite and not more than 1% admixed metallic ion. Particle size was less than 1 mm. Types of debris fragments, dislodged from the crater walls during landing, include bright angular objects which are inferred to be pieces of dense rocky material; dark, rounded objects which are probably aggregates of very fine-grained particles; and dark lumpy objects which appear to be aggregates of aggregates. M.G.J.

N68-17848*# National Aeronautics and Space Administration, Washington, D. C.
LUNAR SURFACE MECHANICAL PROPERTIES
E. M. Christensen, S. A. Batterson, H. E. Benson, R. Choate, R. E. Hutton et al *In its* Surveyor 5 Dec. 1967 p 43–87 refs (See N68-17844 08-31)

Lunar surface mechanical properties data are presented, derived primarily from studies of pictures showing the disturbances caused by the landing and a comparison of pictures taken before and after firing of the vernier engines. Analyses and laboratory simulations were conducted to assist in the interpretation. The results indicate: (1) During the landing slide, at least two footpads dug trenches in the lunar surface material, and ejecta were thrown 90 cm or more. The initial depth of penetration for one footpad was about 13 cm. (2) Best agreement obtained for a compressible soil model with the observed Surveyor 5 footpad penetrations and landing leg loads is for a soil static-bearing capability of 2.7 N/cm^2 and a density of 1.1 g/cm^3. (3) Surface material is granular, slightly cohesive, and generally fine grained, as at the Surveyor 1 and 3 landing sites. (4) During the 0.5-sec vernier engine firing, soil and fragments to undetermined depths were removed by viscous erosion from areas below and adjacent to at least one vernier engine. (5) Permeability of lunar soil, to a depth of 25 cm or so, is 10^{-8} to 10^{-7} cm^2. M.G.J.

N68-17849*# National Aeronautics and Space Administration, Washington, D. C.
LUNAR SURFACE TEMPERATURES AND THERMAL CHARACTERISTICS
J. W. Lucas, R. R. Garipay, W. A. Hagemeyer, J. M. Saari, J. Smith et al *In its* Surveyor 5 Dec. 1967 p 89–101 refs (See N68-17844 08-31)

Following spacecraft reactivation, the Surveyor 5 thermal performance data received on the lunar surface are analyzed for the period until sunset of the second lunar day. Outboard-face

temperatures of compartments A and B were used to derive average brightness temperatures. Among the tentative conclusions reached are: (1) Temperature differences, derived from compartments A and B data during morning and afternoon, may be explained by the different sun phase angles at the local lunar surface. (2) Compartment A predicted and observed surface temperatures show fair agreement in the morning and at noon, and good agreement in the afternoon. For compartment B, there is fair agreement in the morning, good agreement at noon, and poor agreement in the afternoon. Both compartments sensed higher than predicted temperatures at noon. (3) Both compartments telemetered temperatures were higher for the identical sun angles, perhaps because of the deterioration of inorganic white paint. (4) Excellent temperature readings were obtained during the lunar eclipse. M.G.J.

N68-17850*# National Aeronautics and Space Administration, Washington, D. C.

ASTRONOMY

R. H. Norton, J. E. Gunn, W. C. Livingston, G. A. Newkirk, and H. Zirin *In its* Surveyor 5 Dec. 1967 p 103–105 (See N68-17844 08-31)

Following sunset on the first lunar day, 37 pictures of the K- and F-corona were obtained during a 3.5-hour period while using the green filter. The focal length was 100 mm (narrow angle); the lens was focused at 4 meters for each picture. Exposures obtained and the f-ratios used are listed. Author

N68-17851*# National Aeronautics and Space Administration, Washington, D. C.

CHEMICAL ANALYSIS OF THE MOON AT SURVEYOR 5 LANDING SITE: PRELIMINARY RESULTS

A. L. Turkevich, E. J. Franzgrote, and J. H. Patterson *In its* Surveyor 5 Dec. 1967 p 107–132 refs (See N68-17844 08-31)

Details are given on the alpha scattering experiment, designed to measure directly the abundances of the major elements of the lunar surface. Summary information is presented on the characteristics of the alpha scattering instrument which consists of a sensor head deployed directly to the lunar surface, and a digital electronics package located in a thermal compartment on the spacecraft. The alpha scattering analysis and command system are discussed, and the mission sequence is described. Preliminary results of the analysis are assessed. A comparison of the chemical composition of the lunar surface is made with the results of chemical composition analyses of other solar system bodies. The findings show that the Surveyor 5 data are more comparable to the chemical composition of the continental crust of the earth than to that in the outer region of the sun. The conclusion indicated by this comparison is that, if the earth and moon were originally formed from solar-type material, the major geochemical changes to the material at the landing site must have been similar to those that occurred to the materials comprising the terrestrial continents.

N68-17852*# National Aeronautics and Space Administration, Washington, D. C.

LUNAR SURFACE ELECTROMAGNETIC PROPERTIES

J. Negus de Wys *In its* Surveyor 5 Dec. 1967 p 133–154 (See N68-17844 08-31)

To determine the presence and possible amount of material with high magnetic permeability that might be present at the landing site, a magnet assembly was installed on the Surveyor 5. It is pointed out that the materials that would be attracted to a 500-gauss magnet include free iron, magnetite, and Ni–Fe from meteorites, and that the Mare Tranquillitatis landing site is representative of large surface expanses on the side of the moon nearest the earth. Based on the Surveyor 5 pictures of the magnet assembly, it was concluded: (1) Iron is present at the landing site in the form of magnetite, pure iron, meteoritic Ni–Fe fragments, or some combination of these forms of iron. (2) As observed from laboratory studies, an upper limit for iron addition to a naturally occurring rock may be represented by 1% by volume addition of powdered iron. (3) Lunar magnet results are not in disagreement with laboratory results of impact in a 37- to 50-μ powdered basalt with no addition of iron. (4) The Surveyor 5 magnet results indicate considerably less magnetic material than would be expected from entirely meteoritic pulverization and cratering of the lunar surface. M.G.J.

N68-17853*# National Aeronautics and Space Administration, Washington, D. C.

LUNAR THEORY AND PROCESSES

D. E. Gault, J. B. Adams, R. J. Collins, J. Green, G. P. Kuiper et al *In its* Surveyor 5 Dec. 1967 p 155–156 refs (See N68-17844 08-31)

Elemental abundances for six common rock types are compared with preliminary chemical analysis of the lunar landing site; the rock types span the range in silica content from ultramafic to silicic composition. The findings point to a basaltic composition, a conclusion that is consistent with the indications from the magnet experiment. As basalt is derived by chemical fractionation of an ultramafic rock, it seems highly probable that differentiation has occurred in the moon as a result of partial or fractional melting of lunar material. It is considered significant that the chemical composition of the lunar material appears to be similar to a common terrestrial rock, and that the material is not composed of an unusual mixture of elements. Since the geochemical processes on earth do not appear to differ greatly from their lunar counterparts, it is felt that evidence is obtained for the validity of extrapolating terrestrial geochemical and geologic experience to the interpretation of the moon and lunar processes. M.G.J.

N68-17854*# National Aeronautics and Space Administration, Washington, D. C.

APPENDIX A: A STUDY OF CONTAMINATION OF SURVEYOR 5 LANDING SITE BY MAIN RETRO EXHAUST

A. L. Turkevich, E. J. Franzgrote, and J. H. Patterson *In its* Surveyor 5 Dec. 1967 p 157–158 (See N68-17844 08-31)

As the main retrorocket of the Surveyor 5 burned to within 1.6 km of the lunar surface, consideration was given to the possibility that the alpha scattering analysis was affected by the solid particles of aluminum oxide contained in the exhaust. The mass per unit area of aluminum oxide deposited at the landing site was calculated based on the trajectory of the spacecraft, the pointing angle of the retromotor relative to the landing site, the cone angle of the exhaust products, and the mass of aluminum oxide exhausted as a function of burning time. The results show that even if the contamination level were an order of magnitude higher than that estimated, it would be negligible in comparison with the $6.5 \pm 2\%$ aluminum found in the preliminary analysis of the lunar sample. Moreover, because of the high impingement velocity (varying between one and two times the lunar escape velocity), it is considered unlikely that the aluminum oxide particles come to rest on the very surface of the moon at the point of impact. M.G.J.

N68-17884*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.

BASIC STUDIES IN SPACE VEHICLE ATTITUDE CONTROL Semiannual Status Report, Dec. 1966–Dec. 1967

I. Fluegge-Lotz and R. H. Cannon, Jr. Dec. 1967 17 p refs (Grant NsG-133-61)

(NASA-CR-93250; SASR-12) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The research on nonlinear and optimal attitude control of planet-pointing space vehicles continued with Mr. Boykin and with

new Ph.D. candidates under Professor Flügge-Lotz (Sec. A). Basic studies of optimal control, under Professor Franklin, and satellite trajectory studies, under Professor Breakwell, also continue (Secs. A and B). In September, Professor Cannon began a second one-year leave of absence from the University to continue as Scientific Advisor to the Chief of Staff of the Air Force. Consequently, his research remains suspended, and there is nothing to report for him on this Grant for the current period. Because of the oral report given by Professors Flügge-Lotz and Franklin at ERC in June, this report contains information for a one-year period. Author

N68-17891*# Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.
THE CASE FOR ICE CLOUDS ON VENUS
James B. Pollack and Carl Sagan Feb. 1968 17 p refs Prepared jointly with Harvard Coll. Obs.
(Grant NGR-09-015-023)
(NASA-CR-93252; Rept.-801-106) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A paper claiming that ice clouds are inconsistent with the near infrared spectra of Venus is examined. Ice crystals with diameters of a few microns are found to be consistent with polarimetric observations and with all ground-based and high-altitude observations of Venus near 1.5-, 2-, and 3-μ wavelengths. However, it does not seem possible reliably to extract cloud parameters from the spectral details, because uncertainties of 20% or more in absolute reflectivity occur in existing spectra. Ice crystals satisfy this requirement without contradicting data at other wavelengths; various common carbonates, silicates, and oxides, as well as dry ice, do not. The Venera 4 water vapor observations, if reliable, independently demonstrate the existence of ice clouds on Venus, and with optical depths consistent with those obtained from analysis of the near infrared spectra. Some dust may nevertheless be mixed with the ice. Author

N68-17927# Pennsylvania State Univ., University Park. Ionosphere Research Lab.
MAGNETOSPHERIC TAIL STUDIES. 1: ANALYSIS OF HOURLY AVERAGED IMP-C DATA IN THE MAGNETOSPHERIC TAIL. 2: UNCOUPLING OF PARALLEL AND PERPENDICULAR PARTICLE MOTION IN A NEUTRAL SHEET
T. W. Speiser 10 Sep. 1967 24 p refs
(Contract AF 19(628)-4014; Grant NSF GP-5611)
(AFCRL-67-0551; SR-306; AD-663751)

An analysis of two magnetospheric problems comprises the work of the report. The first pertains to an analysis of hourly averaged Imp-C data in the tail with regards to thickness and motion and magnetic variations. The second deals with the uncoupling of parallel and perpendicular particle motion in a neutral sheet. Author (TAB)

N68-17952# Defence Research Board, Ottawa (Ontario).
RE THE CHRONOLOGY OF METEORITES
Alexandre Dauvillier Dec. 1967 5 p refs Transl. into ENGLISH from Bull. Soc. Royale Des Sci. de Liege (France), v. 35, no. 11-12, 1966 p 700-703
(T-5-F)

The chronology of "space rocks" explains why no fossil meteorites are found, and permits us to discard the hypothesis of cosmic panspermia, the hypothesis of biogenic vestiges existing in meteorites, the bombardment theory of the lunar and Martian relief, and the theory of the lunar origin of tectites. Author

N68-18059# Koninklijke Nederlandse Vereniging voor Luchtvaart, The Hague (Netherlands).
SPACE TRAVEL [RUIMTEVAART]
Dec. 1967 76 p In DUTCH; ENGLISH summary
(Rept.-4, V. 16)

This issue contains articles and data as follows: (1) utilization of artificial earth satellites to determine mass density and gravitational characteristics of the earth; (2) a tabulation of annual totals of spacecraft launchings, cumulative manhours in space, and cumulative weight of launched satellites; (3) several Lunar Orbiter photographs of the lunar surface; (4) a listing of satellites observed in the Netherlands during the second half of 1967; (5) a selective bibliography of aerospace literature containing 28 titles; (6) an article on the erosion phenomena at the nozzle of a zinc-sulfur rocket; (7) calculations of composition and performance of a zinc-sulfur-aluminum fuel; and (8) a listing of satellites launched during the period July 1-Oct. 22, 1967 which includes orbital data and a description of some of these satellites. Transl. by K.W.

N68-18061*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 10: SPACE MISSIONS
Richard J. Weber Washington 1968 11 p Presented to Lewis Aerospace Explorers, Cleveland, 1966-1967
(NASA-TM-X-52397) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The characteristic flight paths for interplanetary spacecraft are discussed, along with mission objectives for both manned and unmanned space missions. The space trajectories presented consist of simple conic sections of coasting flights since rockets are only used in providing the acceleration/deceleration forces required to orbit/deorbit the spacecraft. Missions are classified as to objectives (direct—communication, exploration; and indirect—prestige), destinations (lunar, planetary), and type (flyby, manned, unmanned). A typical manned Mars exploration mission is used to illustrate the complexity of the planning required and the number of alternatives available in transporting men and scientific payloads to the planets. The comparative advantages and disadvantages of sounding rockets and satellites in obtaining atmospheric data are briefly summarized. E.J.S.

N68-18079*# North Carolina State Coll., Raleigh.
THEORETICAL INVESTIGATION OF LIQUID WATER INJECTION INTO THE SHOCK LAYER OF A REENTRY VEHICLE
T. C. Dellinger and H. A. Hassan 1967 73 p refs
(Grant NGR-34-002-027)
(NASA-CR-66567) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A method is presented for the calculation of the flow field resulting from the injection of a liquid spray into a supersonic air stream past a blunt body. The model employed assumes a two-phase flow with frozen chemistry and with simultaneous acceleration and evaporation of the spray. The method gives, among other things, the spray penetration. For the range of parameters investigated, the penetration increases with an increase in injection speed, angle, and drop size but is almost independent of the mass flow rate. Because the spray acts to slow and to deflect the air stream, there is initially a rise in the air temperature; the magnitude of this rise is such that finite chemical reaction rates should be taken into consideration for more accurate flow field calculations. Author

N68-18086*# Princeton Univ. Observatory, N. J.
THE INFRARED OPACITY OF HOT WATER VAPOR
Jason R. Auman, Jr. *In* NASA. Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 50-67 refs (See N68-18082 08-33)

As a step in the analysis of the infrared observations of cool stars made from above the atmosphere using a balloon-borne telescope, the opacity due to water vapor was calculated in the spectral region between 0.8 μ and 12.5 μ and for temperatures of 1680°, 2016°, 2520°, and 3360°K. Since the atmospheres are very tenuous in the stars being analyzed, the H_2O spectral lines

and pressure broadening is neglected completely. The spectral lines are assumed to be not only broadened by the atomic thermal motions but also by the assumed rms turbulent motions of 2, 4, and 8 kilometers per second. The positions and the strengths of the total of approximately 2.3×10^8 spectral lines are calculated, and the water vapor spectrum is reconstructed by summing the contributions of these lines. From the reconstructed spectrum the harmonic mean opacity is calculated in intervals of 100 cm^{-1}. The opacity due to H_2O is compared to the continuous opacity assuming that the abundance of the elements is similar to the abundance found in the sun. With this assumption it was found that the H_2O opacity was important at $T=3360^\circ K$ and was the dominant opacity for $T\leq2520^\circ K$. Author

N68-18087*# Texas Univ., Austin. Dept. of Astronomy.
THE SURFACE PRESSURE OF VENUS
L. D. Gray and A. T. Young *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 68–95 refs (See N68-18082 08-33)

An upper limit to the Venus surface pressure of 25 bars is obtained by combining a mechanical model of the atmosphere with an atmospheric model that reproduces the observed microwave brightness temperature of the planet. It is also shown that carbon dioxide is not a minor constituent of the Cytherean atmosphere. Author

N68-18101*# Sacramento Peak Observatory, Sunspot, N. Mex.
THE INVERSION PROBLEM IN STELLAR ATMOSPHERES
Oran R. White *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 380–393 refs (See N68-18082 08-33)

Because of the large distances and extreme physical conditions involved, the radiation from stars is the only source of information on stellar constitution. The analysis of this radiation necessarily requires inversion of the intensity integral in order to estimate the run of physical conditions with depth. As an example of the stellar atmospheres problem, the basic data and analytic techniques for analysis of solar limb darkening data are given. The analytic approach is general enough to allow for departures from thermodynamic equilibrium. Author

N68-18105*# Heliodyne Corp., Norton AFB, Calif.
MOLECULAR TEMPERATURE DETERMINATIONS IN FLOW FIELDS OF RE-ENTERING BODIES
Walter G. Planet, R. Watson, and C. C. Pitts *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 416–427 refs (See N68-18082 08-33)
(Contract F04694-67-C-0148)

Molecular temperature determinations represent a technique for the diagnosis of the flow fields of reentering bodies. During a typical reentry test, remote spectrographic systems acquire large quantities of optical data. With appropriate data reduction and analysis procedures, standard spectroscopic techniques can be applied to these large stores of data to yield estimates of the flow-field gas temperatures. The important features of a procedure, which uses radiation from the CN $A^2\Sigma \rightarrow X^2\Sigma$ (violet) band system to determine the temperature, are discussed. Author

N68-18117*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPLORING IN AEROSPACE ROCKETRY. 9: ROCKET TRAJECTORIES, DRAG, AND STABILITY
Roger W. Luidens Washington 1968 21 p Presented to Lewis Aerospace Explorers, Cleveland, 1966–1967
(NASA-TM-X-52396) CFSTI: HC$3.00/MF$0.65 CSCL 22A

The powered flight, coasting, and parachute descent trajectory phases of a typical rocket flight are described, and equations of motion are formulated for both the individual trajectories and for the orbital flight. The effects of friction and form drag on rocket flight paths and maximum attainable altitudes are briefly discussed. Methods for locating the center of gravity and center of pressure are presented, and the relationship between these points and the positive static stability of the rocket is shown. E.J.S.

N68-18137*# Techtran Corp., Glen Burnie, Md.
THE FORMATION OF BINARY STARS [OB OBRAZOVANII DVOINYKH ZVEZD]
L. E. Gurevich and B. Yu. Levin Washington NASA Feb. 1968 19 p refs Transl. into ENGLISH from Astron. Zh. (USSR), v. 27, no. 5, 1950 p 273–284
(Contract NASw-1695)
(NASA-TT-F-11541) CFSTI: HC$3.00/MF$0.65 CSCL 03B

The formation and disruption of binaries in a near-equilibrium star cluster is analyzed. The authors conclude that in certain star clusters the mean star density is high enough for the formation of large numbers of binaries through random encounters of single stars. Mechanism of "evaporation" from such clusters is proposed to explain the relatively large numbers of binaries outside clusters. Author

N68-18169# Royal Aircraft Establishment, Farnborough (England).
OPTIMUM FUNCTIONS FOR MASS AND ENERGY FLOW IN SPACE MANOEUVRES
E. G. C. Burt Oct. 1967 55 p ref
(RAE-TR-67267; AD-663578)

The mass and energy expended during the transfer of a space vehicle from one orbit to another depend both on the magnitude of the orbital change and on the spacecraft propulsion variables. In the paper the optimum time behaviour of these variables is investigated: that is, those functions which maximize the residual mass of the spacecraft, or which minimize the total energy required for a given total equivalent velocity change. It is found that an optimum relation exists between the flow of mass and of energy (which may also be expressed in terms of exhaust velocity, thrust, etc.): and that, provided this condition is satisfied, the results depend only on the total energy supplied, and not on the way it is released. The optimum functions and maximum mass ratios derived in the paper apply in the general case where the efficiency of the propulsion system varies with exhaust velocity, and when the ejected mass possesses intrinsic energy in addition to that supplied from a separate source. Formulae are also developed for the maximization of the useful or disposable mass, and various examples are given. Author (TAB)

N68-18173*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
PRIMORDIAL HELIUM AND THE LUMINOSITY OF HORIZONTAL-BRANCH STARS
Daiichiro Sugimoto and Naruyoshi Asano (Nagoya Univ.) Feb. 1968 17 p refs
(NASA-TM-X-63109; X-641-68-42) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The discovery of the 3°K cosmic blackbody radiation has provided compelling evidence for element synthesis in a primordial fireball. In particular, the primordial helium abundance by mass, $Y=0.27$ should therefore be found in present-day population II stars. We are concerned in this paper with the confirmation of the existence of the primordial helium. It is well known that the direct determination of helium abundances is difficult, especially in the population II stars. The indirect approach of comparing theoretical stellar models with observation also leads to difficulties, since in many cases the stellar evolution depends upon the stellar mass, which is often observationally uncertain. Our approach involves the

latter method, but considers only certain types of stars whose absolute magnitudes are insensitive to the stellar mass, viz., horizontal-branch stars in globular clusters and field RR Lyrae stars. Author

N68-18176*# Smithsonian Institution, Washington, D. C.
METEOR MASSES AND LUMINOSITY
Franco Verniani 1967 18 p refs *Its* Contrib. to Astrophys., V. 10, No. 3
(Grant NSR-09-015-033)
(NASA-CR-93362) GPO: HC $0.20; CFSTI: MF $0.65 CSCL 03B

In 1964, the author published a study of the meteor luminous efficiency based on Harvard's photographic data. This paper presents a more sophisticated analysis of the same data since it takes better into account the effects of fragmentation. On the whole, 1964 results are confirmed, but the accuracy is greatly improved. The luminous efficiency can be expressed as a function of velocity, and the luminosity expressed in units of 0-mag stars. Uncertainty is ±0.1 in the velocity exponent and about 40% in the coefficient. A mass scale has been established, and meteor densities have been determined. Most meteors, both sporadic and shower, have an average density in the vicinity of 0.2 g cm^{-3}. It appears, however, that a small group of sporadic meteors in very short orbits exists, with higher densities on the order of 1 g cm^{-3}. Because of selection effects, it is impossible to estimate the actual consistency of this group, it is clear however, that it must represent a very small minority of cometary meteors. Author

N68-18185*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
TOLIP: TRAJECTORY OPTIMIZATION AND LINEARIZED PITCH COMPUTER PROGRAM
Robert E. Willwerth, Jr. and Richard C. Rosenbaum [1967] 266 p refs
(Contract NAS1-5106)
(NASA-CR-65515) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The Scout trajectory optimization and linearized pitch computer program performs the trajectory-related calculations necessary in mission-planning and preflight analysis with a large reduction in computer time. It uses a closed-loop steepest descent optimization procedure to obtain flight trajectories that maximize payload, inertial or aerodynamic velocity, or altitude for up to five-stage vehicles. The program is automatically linearized to enable its mechanization in the autopilot system. Control system and body dynamics effects are included in the simulation. A large number of constraints on the trajectory and pitch program can be included in the optimization and linearization solutions. Following the solution for the optimum trajectory and pitch program, the computer program can proceed, by option, directly into calculating: (1) radar tracking coordinate histories for up to twenty stations; (2) the locus of nominal impact points of the spent stages; (3) nominal dispersion envelopes; and (4) failure-mode hardover turns. For planning purposes, first-order performance exchange ratios for several vehicle/motor characteristics are calculated. Author

N68-18195*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AERO-ASTRODYNAMICS RESEARCH REVIEW NUMBER SIX
William D. Murphree, ed. 15 Oct. 1967 166 p refs
(NASA-TM-X-53647) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The topics discussed in this research review cover a variety of subjects. Included are Flight Mechanics, Fluid Dynamics, Planetary Environments, Rarefied Gas Dynamics, Solar Physics, Selenography, and Thermodynamics. Also included, under the heading "Publications and Presentations," are the titles and abstracts of the reports and papers which have been prepared during the past year. First, NASA reports are listed, followed by those papers which have been presented at symposia and those which were printed in the open literature. It should be noted that no single review treats all subject areas being investigated by the Laboratory. Further, these reviews are not progress reports; rather it is attempted here to publish works of a research nature which have reached a milestone worthy of note. Other subjects will be discussed in forthcoming reviews. Author

N68-18203*# Techtran Corp., Glen Burnie, Md.
NOTES ON THE PROBLEM OF CONTROLLING MANNED SPACECRAFT [ZAMECHANIYA O PROBLEME UPRAVLENIYA PILOTIRUYEMOGO KOSMICHESKOGO APPARATA]
N. N. Moiseyev Washington NASA Feb. 1968 3 p Transl. into ENGLISH from the Russian Report Presented at the 18th Congr. of the Intern. Astron. Federation, Belgrade, 25–30 Sep. 1967
(Contract NASw-1695)
(NASA-TT-F-11570) CFSTI: HC $3.00/MF $0.65 CSCL 22A

One of the most important problems concerning manned spacecraft development is that of the synthesis of a control system. Obviously, any spacecraft must contain a computer; this computer will generally be a specialized, rather than universal, computer, required to solve only a certain definite range of preprogrammed problems. The presence of the on-board computer requires that the problem of synthesis be stated anew. This is explained using the example of orbital adjustments. Author

N68-18244# Royal Aircraft Establishment, Farnborough (England).
THE CONTRACTION OF SATELLITE ORBITS UNDER THE INFLUENCE OF AIR DRAG. PART 6: NEAR-CIRCULAR ORBITS WITH DAY-TO-NIGHT VARIATION IN AIR DENSITY
G. E. Cook and D. G. King-Hele Apr. 1967 41 p refs
(RAE-TR-67092, Pt. 6; AD-663588)

The theory for the effect of air drag on satellite orbits was developed in Parts I-V of this series of papers on the assumption that the angular motion of perigee is controlled by gravitational forces and is not affected by air drag. If the orbital eccentricity is less than about 0.01, however, and the atmosphere exhibits a substantial day-to-night variation in density, the air drag itself significantly affects the angular motion of perigee. In these circumstances the mathematical theory takes a different and more complicated form, which is developed in the present paper. General equations are derived for the rate of change of parameters representing the eccentricity and argument of perigee. Complete analytical solutions for the time variations of these parameters are obtained for orbits of very small eccentricity in two different forms, for (1) high drag, i.e. short lifetime, and (2) low drag. The results are illustrated by numerical examples. Author (TAB)

N68-18255# Joint Inst. for Lab. Astrophysics, Boulder, Colo.
ON THE EMISSION OF ATOMIC HYDROGEN IN COMETS
L. Biermann 30 Jan. 1968 16 p refs Prepared jointly with Colo. Univ. and Natl. Bur. of Std.
(JILA-93) CFSTI: HC $3.00/MF $0.65

In order to explain the phenomena of emission of atomic hydrogen in comets, several theories are discussed in relation to the mass and chemical composition of a comet. An assessment is made of the Lyman alpha and beta radiation emitting from medium bright comets. Consideration is also given to the dissociation processes of atomic hydrogen going on in the head of the comet, along with the solar activity and the comet's radial velocity with respect to the sun. It is concluded that for the earth's high atmosphere, the optical depth of the hydrogen atmosphere for Ly β should be smaller than that for the center of the Ly α. B.S.D.

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N68-17387*# Atlantic Research Corp., Alexandria, Va.
FIRE HAZARDS IN SPACECRAFT ATMOSPHERES
Clayton Huggett *In* NASA. Marshall Space Flight Center 5th Ann. Meeting. Working Group on Extraterrest. Resources 3 Mar. 1967 p 191–198 refs (See N68-17350 08-30)

The hazards in oxygen, oxygen–nitrogen, and oxygen–helium atmospheres were investigated, along with the effect of storage in the atmospheres on simulator chamber materials. Tabulated and graphed data are presented on the energy required for ignition, flame spread rates, and storage effects, emphasizing oxygen atmosphere. It was found that the presence of an inert gas diluent reduces the rate of flame spread and fire buildup. It was further determined that the possibility of fire can be reduced by careful attention to design and materials selection. N.E.N.

N68-17411*# Jet Propulsion Lab., Calif. Inst. of Tech. Pasadena.
SURVEYOR SURFACE SAMPLER INSTRUMENT
E. R. Rouze, M. C. Clary, D. H. Le Croissette, C. D. Porter, and J. W. Fortenberry 1 Feb. 1968 51 p refs
(Contract NAS7-100)
(NASA-CR-93205; JPL-TR-32-1223) CFSTI: HC $3.00/MF $0.65 CSCL 22B

This report presents the objectives planned for the surface sampler lunar experiment, as well as details of design of the flight hardware, mounting techniques, and thermal control. Operational capabilities, methods of deployment command and control, and areas of lunar operation and television viewability are discussed. The report concludes with a description of the surface sampler mission operation and a summary of surface sampler activities during the first lunar day of the Surveyor III mission. Author

N68-17413# European Space Research Organization, Paris (France).
CONTROL AND STABILISATION OF SPACECRAFT. VOLUME 1: INTRODUCTION AND SEMINARS
Jun. 1967 387 p refs Proc. of the 4th ESRO Summer School, held in Helsingor, Denmark, Aug.–Sep. 1966
(ESRO-SP-16) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. INTRODUCTION TO SPACECRAFT ATTITUDE CONTROL W. G. Hughes (Royal Aircraft Establish.) p 13–35 (See N68-17414 08-21)

2. OPERATION OF THE L.A.S. CONTROL SYSTEMS D. Marsh p 47–65 (See N68-17415 08-21)

3. DESIGN OF ATTITUDE LOOPS FOR THE L.A.S. B. Sunesson p 67–90 (See N68-17416 08-21)

4. NIMBUS STABILIZATION AND CONTROL L. T. Seaman (GE) p 91–129 refs (See N68-17417 08-21)

5. A SATELLITE ATTITUDE CONTROL SYSTEM USING PROPANE J. L. Tracy (Elliott Bros., Ltd.) p 131–163 refs (See N68-17418 08-21)

6. THE CONTROL OF THE ATTITUDE OF SOUNDING ROCKETS P. E. G. Cope (Elliott Bros., Ltd.) p 165–188 (See N68-17419 08-21)

7. THE CASSIOPEIA SYSTEM C. Poher (Centre Natl. d'Etudes Spatiales) p 189–201 (See N68-17420 08-21)

8. ELEMENTS OF CONTROL THEORY J. Billingsley (Cambridge Univ.) p 203–222 refs (See N68-17421 08-10)

9. BOUNDARY LAYER SEPARATION APPLIED TO THRUST VECTOR CONTROL R. V. Thompson (Strathclyde Univ.) p 223–238 refs (See N68-17422 08-12)

10. SIMULATION AND TESTING OF SPACECRAFT ATTITUDE CONTROL SYSTEMS E. Slachmuylders p 249–289 (See N68-17423 08-21)

N68-17498*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
AN INVESTIGATION OF LEAKAGE OF LARGE-DIAMETER O-RING SEALS ON SPACECRAFT AIR-LOCK HATCHES
Otto F. Trout, Jr. Washington Mar. 1968 38 p refs
(NASA-TN-D-4394) CFSTI: HC $3.00/MF $0.65 CSCL 22A

An investigation has been conducted to determine the leakage of large-diameter O-ring seals for operable hatch doors and static joints with a vacuum of 1.0×10^{-6} torr on one side and atmospheric pressure on the other. The measuring techniques employed made it possible to determine the leakage of any hatch component of an air-lock system. Tests of O-ring seals 28 to 30 inches in diameter have indicated that helium leakages of less than 1.0×10^{-5} cc/sec (STP) are attainable with butyl, viton, and neoprene elastomers for operable hatch doors and static seals. Silicone elastomeric O-rings allowed considerably greater leakages. The results indicate that the leakage of O-ring seals is sufficiently low for atmospheric containment on manned spacecraft under the conditions of this investigation. Author

N68-17639# Laboratoire de Recherches Balistiques et Aerodynamiques, Vernon (France).
NOTE ON FILLING DEVICES: OVERFLOW AND FILLING VANES [NOTE SUR LES ORGANES DE REMPLISSAGE: TROP PLEIN N ET U ET REMPLISSAGE N ET U]
M. Neaud 20 Dec. 1967 17 p In FRENCH
(TN-109/67-EP) CFSTI: HC $3.00/MF $0.65

Characteristics and specifications of the filling vanes and connectors developed for the ELDO launch vehicle are given. ESRO

N68-17652# Giravions Dorand Co., Paris (France).
SPACE ROTOR: A FRENCH PROJECT FOR SPACECRAFT RECOVERY [ROTOR SPATIAL: CONCEPT FRANCAIS POUR LA RECUPERATION DES VEHICULES SPATIAUX]
Marcel Kretz Jan. 1967 18 p refs In FRENCH Presented at the 2d SAE Space Technol. Conf., Palo Alto, Calif., 9–12 May 1967
CFSTI: HC $3.00/MF $0.65

The spacerotor described in this paper has been designed to provide a light and flexible means of re-entry for spacecraft and boosters. It has a weight of 11–14% of the carried load which is, by far, less than any known recovery vehicle, so that a given launcher will satellize an effective load about twice as heavy as in the case of other recovery vehicles. A gyroglider used as re-entry vehicle will be much lighter as it will require a lighter structure and no heat shield. The variation of temperature in the blades will not exceed $\pm10^{\circ}$C and the mean temperature can be kept low by proper action on the blade profile. As a recovery means for a booster it will reduce the dynamic pressure in flight and avoid turbulent flow conditions. Some indications are given for recovery of manned spacecraft. ESRO

N68-17844*# National Aeronautics and Space Administration, Washington, D. C.
SURVEYOR 5 Preliminary Report
Dec. 1967 162 p refs
(NASA-SP-163) CFSTI: HC $3.00/MF $0.65 CSCL 22A

CONTENTS:

1. PRINCIPAL SCIENTIFIC RESULTS L. D. Jaffe, S. A. Batterson, W. E. Brown, Jr., E. M. Christensen, S. E. Dwornik et al p 1–2 (See N68-17845 08-30)

2. INTRODUCTION B. Milwitzky and S. E. Dwornik p 3–8 (See N68-17846 08-31)

3. TELEVISION OBSERVATIONS FROM SURVEYOR V E. M. Shoemaker, R. M. Batson, H. E. Holt, E. C. Morris, J. J. Rennilson et al p 9–42 refs (See N68-17847 08-31)

4. LUNAR SURFACE MECHANICAL PROPERTIES E. M. Christensen, S. A. Batterson, H. E. Benson, R. Choate, R. E. Hutton et al p 43–87 refs (See N68-17848 08-30)

5. LUNAR SURFACE TEMPERATURES AND THERMAL CHARACTERISTICS J. W. Lucas, R. R. Garipay, W. A. Hagemeyer, J. M. Saari, J. Smith et al p 89–101 refs (See N68-17849 08-30)

6. ASTRONOMY R. H. Norton, J. E. Gunn, W. C. Livingston, G. A. Newkirk, and H. Zirin p 103–105 (See N68-17850 08-30)

7. CHEMICAL ANALYSIS OF THE MOON AT SURVEYOR 5 LANDING SITE: PRELIMINARY RESULTS A. L. Turkevich, E. J. Franzgrote, and J. H. Patterson p 107–132 refs (See N68-17851 08-30)

8. LUNAR SURFACE ELECTROMAGNETIC PROPERTIES J. Negus de Wys p 133–154 (See N68-17852 08-30)

9. LUNAR THEORY AND PROCESSES D. E. Gault, J. B. Adams, R. J. Collins, J. Green, G. P. Kuiper et al p 155–156 refs (See N68-17853 08-30)

10. APPENDIX A A STUDY OF CONTAMINATION OF SURVEYOR 5 LANDING SITE BY MAIN RETRO EXHAUST A. L. Turkevich, E. J. Franzgrote, and J. H. Patterson p 157–158 (See N68-17854 08-30)

N68-17846*# National Aeronautics and Space Administration, Washington, D. C.

INTRODUCTION

B. Milwitzky and S. E. Dwornik *In its* Surveyor 5 Dec. 1967 p 3–8 (See N68-17844 08-31)

Design details on the Surveyor 5 configuration and instrumentation are discussed and depicted, and the tracking and data acquisition support facilities are reviewed. The primary mission objectives are defined as performing a soft landing in Mare Tranquillitatis, and obtaining postlanding television pictures of the lunar surface. Secondary objectives are listed as conducting a vernier-engine erosion experiment; determining the relative abundance of the chemical elements in the lunar soil by operation of the alpha scattering instrument; and obtaining touchdown dynamics data, and thermal and radar reflectivity data. A chronology of the flight operations is presented, along with the emergency measures taken to evolve a new terminal descent profile. The successful lunar surface operations are summarized. M.G.J.

N68-17847*# National Aeronautics and Space Administration, Washington, D. C.

TELEVISION OBSERVATIONS FROM SURVEYOR 5

E. M. Shoemaker, R. M. Batson, H. E. Holt, E. C. Morris, J. J. Rennilson et al *In its* Surveyor 5 Dec. 1967 p 9–42 refs (See N68-17844 08-31)

Various facets of the Surveyor 5 transmission of more than 18,000 high quality television pictures of the lunar surface and parts of the spacecraft are examined. The total response range of the television camera is about 1,000,000 to one, achieved by the combined use of various filters, apertures, and exposure times. After landing, the mirror and optical parts of the camera were clean and free of dust and dirt particles, resulting in the highest quality pictures yet received from a Surveyor spacecraft. The inflight tracking data used to determine the landing site are discussed, along with the preparation of preliminary topographic maps of small areas on the surface surrounding Surveyor 5. Crater morphology and distribution are described, and consideration is given to surficial debris, the size–frequency distribution of fragmental debris, and photometric measurements of the undisturbed and disturbed lunar surface. Photographs illustrating these findings are included, and geologic observations are interpreted. M.G.J.

N68-17867*# Michigan Univ., Ann Arbor. Space Physics Research Lab.

ENGINEERING DESIGN OF A PITOT-STATIC PROBE PAYLOAD Engineering Report No. 2

G. F. Rupert Apr. 1967 171 p refs

(Contract NAS5-3335; ORA Proj. 05776)

(NASA-CR-93251; Rept.-05776-2-E) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The engineering aspects of the Pitot-Static Probe experiment are presented with emphasis on the design and fabrication of the special instrumentation and circuits that were developed to make implementation of the technique possible. The fabrication of the mechanical system, testing procedures, and a prelude of launch operations are included. Future considerations toward system improvements and greater measurement accuracy conclude the report. Author

N68-17909# Royal Aircraft Establishment, Farnborough (England).

TABLE OF SPACE VEHICLES LAUNCHED IN 1950–66

H. Hiller Mar. 1967 17 p refs

(RAE-TR-67059; AD-663873)

All known space vehicles launched before 1 January 1967, which are not geocentric satellites, are tabulated here. The table is divided into three sections, under the headings (a) heliocentric orbits, (b) orbits in the earth-moon system and (c) selenocentric orbits. Author (TAB)

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N68-17374# Lockheed Missiles and Space Co., Sunnyvale, Calif.

STRESS CONCENTRATION AROUND A NONSYMMETRICALLY REINFORCED HOLE IN A PLATE

A. P. Tarasenko 1967 4 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk. Uk. RSR (Kiev), no. 12, 1967 p 1107–1111

The stress state of a plate with a nonsymmetrically reinforced hole is investigated under a high total loading: bilateral tension, or bilateral bending of the plate. It is assumed that the curved hole of an infinite plate is reinforced by a thin elastic rib of constant cross section so that the whole rib is displaced a distance from the middle plane of the plate. The materials of the rib and plate are assumed to be different, homogeneous, and isotropic. Author

N68-17384*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

BEHAVIOR OF TRIANGULAR SHELL ELEMENT STIFFNESS MATRICES ASSOCIATED WITH POLYHEDRAL DEFLECTION DISTRIBUTIONS

Senol Utku and Robert J. Melosh (Philco-Ford Corp., Palo Alto, Calif.) 15 Feb. 1968 25 p refs Presented at the 5th AIAA Aerospace Sci. Meeting, New York, Jan. 1967 *Its* Paper 67–114

(Contract NAS7-100)

(NASA-CR-93206; JPL-TR-32-1217) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Invariants of the triangular shell element stiffness matrices are examined. The stiffness matrix is considered as the sum of membrane bending and transverse shear stiffness matrices representing respective strain energies. For various geometries and curvatures, eigenvalues of these matrices are obtained numerically. By studying the eigenvalues, it is shown that stiffness matrices produced with the help of equilibrium requirements may display

nonpositive behavior depending upon element geometry. The grave consequences of nonpositive behavior are demonstrated. Since equilibrium algorithms can be used to accelerate the convergence, two schemes are developed to correct the nonpositve behavior. These schemes are based on the observation that nonpositive behavior originates from the base matrix to which equilibrium algorithm is applied. The effect of thickness/area ratio on the overall behavior is studied. The behavior associated with true potential energy approach is demonstrated on several test cases. The effect of geometry is also discussed in the assembled matrix. Guidelines were presented for the use of the triangular shell element in structural analyses. Author

N68-17425# Office National d'Etudes et de Recherches Aerospatiales, Paris (France)

METHOD FOR OBTAINING THE NATURAL MODES BY CALCULATION OF THE OPTIMUM HARMONIC EXCITATION BASED ON THE CRUDE RESULTS OF VIBRATION TESTS [METHODE DE RECHERCHE DES MODES PROPRES PAR CALCUL DE L'EXCITATION HARMONIQUE OPTIMUM D'APRES LES RESULTATS BRUTS D'ESSAIS DE VIBRATIONS]

Daniel Clerc 1967 58 p refs In FRENCH; ENGLISH summary
(ONERA-NT-119)

The precise research of the natural modes of an elastic structure presents serious difficulties, particularly in the case of distinct natural forms of neighboring frequencies. The success of the operation depends essentially on the more or less correct adaptation of the excitation forces to the natural modes to be determined. It is shown that this adaptation is more and more precise as the number of exciters increases, but the exact forces become more and more difficult to evaluate since the usual way to proceed consists of an empirical determination. The present method aims at overcoming this disadvantage by substituting to the empirical determination a systematic calculation giving the best adjustment of the forces. During a series of tests a dual survey is made to obtain the frequency and the force adaptation. The results, appropriately recorded, are then introduced in a calculation which gives the precise optimum adaptations and the corresponding response, that is to say the natural form. Then the calculation determines the generalized mass by simulation of a usual process such as that of the forces in quadrature. A numerical application of this method to a simple model is given. Author

N68-17434# Office National d'Etudes et de Recherches Aerospatiales, Paris (France)

EQUIPMENT FOR FLIGHT VIBRATION TESTS OF THE SST CONCORDE [APPAREILLAGE D'ESSAIS DE VIBRATION EN VOL DE L'AVION CONCORDE]

Gerard Piazzoli 1967 29 p refs In FRENCH; ENGLISH summary
(ONERA-NT-120)

A special equipment for vibration tests was developed for studying the aeroelastic behavior of the SST Concorde. Because of the structural flexibility of the airplane, of the severe environment in the flight domain, of the safety prerequisites, and of the necessary reliability, the solutions adapted are situated at the advanced level of today's technological possibilities. Nineteen seismic electro-dynamic excitors belonging to four types will be located on the wing on the tail and inside the fuselage. Particular attention will be paid to the programming of the appropriation of the vibratory shapes as well as to the optimization of the time given to the testing sequences. Qualification tests of this equipment were carried out with a dynamic balance simulating as closely as possible the elastic parameters of the structure and the most critical environment. Measurements carried out in this manner give results very nearly the same as those predicted. Author

N68-17482# Lockheed Missiles and Space Co., Sunnyvale, Calif.

ON THE THEORY OF A TWO-LAYER CYLINDRICAL FIBERGLASS SHELL

D. A. Karpova 1967 6 p refs Transl. into ENGLISH from Dopovidi Akad. Nauk Uk. RSR (Kiev), no. 12, 1967 p 1101–1106

Consideration is given to a two-layer circular cylindrical shell of unidirectional fiberglass, in which the inner layer is constructed from longitudinal windings, and the outer layer from transverse windings of glass fibers. It is assumed that the glass fibers form a hexagonal structure in such a packing. The stress tensor components are expanded in series, and it is noted that the first two coefficients of the series are components of the internal forces and moments used in shell theory and satisfy known equilibrium equations. To determine the unknown series coefficients, the Castigliano principle is used, and reduced to the determination of the minimum of some functional. The elasticity relationships for a two-layer cylindrical shell are found, with two versions of the formulas obtained. It is shown that in the proposed method the solution of three-dimensional elasticity theory problems can be obtained with preassigned accuracy. M.G.J.

N68-17489# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugzeugbau.

AXISYMMETRIC DEFORMATIONS OF ECCENTRICALLY STIFFENED AND ORTHOTROPIC CYLINDER SHELLS [AXIALSYMMETRISCHE VERFORMUNGEN VON EXZENTRISCH VERSTEIFTEN ORTHOTROPEN KREISZYLINDERSCHALEN]

Hermann Appel and Bodo Geier 30 Nov. 1967 68 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-82)

The stress-problem and the stability-problem of eccentrically stiffened orthotropic circular cylinders with axisymmetric loads, supports and deformations is investigated. Explicit solutions of the radial deformations and of the shortening are given for various boundary conditions and for eccentric axial loading. In the case of circumferential stiffening the ring buckling load may be the decisive critical load. It is influenced by the eccentricity of the longitudinal stiffeners and not influenced by the eccentricity of the circumferential stiffeners. The comparison of the radial deformations and of the stresses in circumferential direction in the prebuckling region of cylinders with hinged edges gives an explanation of the recently calculated differences of the buckling loads of cylinders with different eccentricities of the axial load. Author

N68-17490# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugzeugbau.

CREEP RUPTURE STRENGTHS AND CREEP DEFLECTION OF OVERLAPPED METAL BONDED JOINTS IN THE TEMPERATURE REGION FROM +20°C TO +175°C [ZEITSTANDFESTIGKEITEN UND KRIECHVERFORMUNGEN VON UEBERLAPPTEN METALLKLEBUNGEN IM TEMPERATURBEREICH VON +20°C BIS +175°C]

Walter Althof 20 Nov. 1967 51 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-80) CFSTI: HC $3.00/MF $0.65

Single lap metal bonded joints have been investigated in tension-shear-creep-rupture-tests at different temperatures. As adherend stainless steel was used being bonded with an epoxid-phenol-resin adhesive. The overlap length are $1_ü$ = 10,20 and 40 mm respectively. The tests have been carried out within a temperature region from +20°C up to +175°C. Thereby, the creep deflection of the bond line was measured and diagrams were recorded, demonstrating the creep-rupture-stress versus time and creep-deflection versus time. In some tests, in which the damage of the joint due to the creep was investigated, an ultimative creep limit could be determined. The creep-diagrams were compared in order to find out the influence of loading, overlap length and temperature on the creep deflection of the bond line. Author

N68-17499# Southampton Univ. (England). Inst. of Sound and Vibration Research.

NUMERICAL METHODS FOR VIBRATION PROBLEMS. VOLUME 1: THE FORMULATION AND APPROXIMATE SOLUTION OF VIBRATION PROBLEMS

15 Jul. 1966 88 p refs Symp. held 12–15 Jul. 1966

CONTENTS:

1. A NOTE ON COARSE APPROXIMATIONS AND RULES IN LINEAR VIBRATION THEORY R. D. E. Bishop (Univ. Coll.) p 1–14 refs (See N68-17500 08-32)

2. VARIATIONAL METHODS FOR THE DERIVATION OF APPROXIMATE EQUATIONS OF MOTION FOR ELASTIC BEAMS A. D. S. Barr (Edinburgh Univ.) p 15–27 refs (See N68-17501 08-32)

3. THE FORMULATION OF VIBRATION PROBLEMS G. M. L. Gladwell p 28–34 (See N68-17502 08-32)

4. ECONOMICAL METHODS FOR FINDING EIGENVALUES AND EIGENVECTORS E. Cohen and H. McCallion p 35–50 refs (See N68-17503 08-32)

5. THE FINITE ELEMENT TECHNIQUE APPLIED TO AN ACOUSTIC DAMPLING PROBLEM V. Mason p 50–56 refs (See N68-17504 08-32)

6. FREQUENCY TUNING OF COMPRESSOR ROTOR BLADES K. Fullard (Rolls-Royce, Ltd.) p 57–65 (See N68-17505 08-32)

7. THE STODOLA METHOD APPLIED TO SANDWICH BEAM VIBRATION D. J. Mead and S. Sivakumuran p 66–80 ref (See N68-17506 08-32)

N68-17500# University Coll., London (England). Dept. of Mechanical Engineering.

A NOTE ON COARSE APPROXIMATIONS AND RULES IN LINEAR VIBRATION THEORY

R. D. E. Bishop *In* Southampton Univ. Numerical Methods for Vibration Probl., Vol. 1, 15 Jul. 1966 p 1–14 refs (See N68-17499 08-32)

Linear constraints, receptance theory, analytical techniques, and energy methods are discussed in relation to practical linear vibration analysis problems and computerized solutions. These four techniques permit the derivation of rules to determine whether computer results make sense from a physical standpoint and represent the true nature of the vibration problem. M.W.R.

N68-17501# Edinburgh Univ. (Scotland). Dept. of Mechanical Engineering.

VARIATIONAL METHODS FOR THE DERIVATION OF APPROXIMATE EQUATIONS OF MOTION FOR ELASTIC BEAMS

A. D. S. Barr *In* Southampton Univ. Numerical Methods for Vibration Probl., Vol. 1 15 Jul. 1966 p 15–27 refs (See N68-17499 08-32)

Two examples indicate the application of the extended Hu-Washizu principle to the derivation of approximate equations of motion for elastic beams; and allow for independent variation of stress, strain, and displacement components. The basic equations of the dynamical problem in classical elasticity are stated in cartesian coordinates, and the dynamic Hu-Washizu principle is extended by introducing velocity components as well as inertia forces into the equilibrium equations. The equation envolved is then applied to the construction of approximate theories for beams, and examples illustrate both the Bernoulli–Euler beam equation and the bending-twisting vibration of curved beams. M.W.R.

N68-17502# Southampton Univ. (England). Inst. of Sound and Vibration Research.

THE FORMULATION OF VIBRATION PROBLEMS

G. M. L. Gladwell *In its* Numerical Method for Vibration Probl., Vol. 1 15 Jul. 1966 p 28–34 (See N68-17499 08-32)

Relations between the various method of formulating vibration problems are presented, with emphasis on those formulations that can be expressed as variational principles. It is also shown that vibration problems can be formulated as systems of differential equations in time and in one or more space variables. The differential equations can be solved by finite difference methods, while the variational principles are suitable for use with finite element methods. The time-independent form of Hamilton's principle, when used with an assumed mode form for the displacements, will yield a dynamic stiffness matrix of an element. D'Alembert's principle, Rayleigh's principle, and the Euler-Lagrange equations for Hamilton's principle are discussed. M.W.R.

N68-17503# Southampton Univ. (England). Inst. of Sound and Vibration Research.

ECONOMICAL METHODS FOR FINDING EIGENVALUES AND EIGENVECTORS

E. Cohen and H. Mc Callion *In its* Numerical Method for Vibration Probl., Vol. 1 15 Jul. 1966 p 35–50 refs (See N68-17499 08-32)

Natural frequencies for eigenvalues and eigenvectors are found by extending Rayleigh's principle to utilize the orthogonality properties of the normal modes. The method does away with the and error location of natural frequencies. This method results in an upper bound for each natural frequency, and can find a very accurate natural frequency from a few applications. The system matrix is linearized to permit a more rapid evaluation of eigenvalues and eigenvectors. An easily programmed method of setting up the frequency determinant is also described, as is a method for finding eigenvalues and eigenvectors of frequency equations with transcendental functions as elements. A comparison of eigenvalues is tabulated, as are mode shapes for frequency 558.350 c/s. M.W.R.

N68-17504# Southampton Univ. (England). Inst. of Sound and Vibration Research.

THE FINITE ELEMENT TECHNIQUE APPLIED TO AN ACOUSTIC DAMPING PROBLEM

V. Mason *In its* Numerical Method for Vibration Probl., Vol. 1 15 Jul. 1966 p 50–56 refs (See N68-17499 08-32)

A finite element computational approach to the prediction of the response of structures to acoustic excitation is presented. While attention is given to the response of a rectangular flat plate mounted in an infinite rigid baffle and excited by plane acoustic waves, the suggested method is applicable to the response of a plate with arbitrary shape and edge conditions to sirens, sonic boom, or other acoustic excitation. Details are included for both the mathematical and computer formulations of the problem that will enable determination of both plate response and acoustic transmission. Frequency limitations to the range of meaningful results are caused by the assumption of constant pressure over an element and the accuracy of the finite element representation of the plate. The former can be relaxed slightly by assuming constant pressure over subdivisions of an element, and the latter can be aided by an eigenvalue analysis. M.W.R.

N68-17505# Rolls-Royce, Ltd., Derby (England).

FREQUENCY TUNING OF COMPRESSOR ROTOR BLADES

K. Fullard *In* Southampton Univ. Numerical Methods for Vibration Probl., Vol. 1 15 Jul. 1966 p 57–65 (See N68-17499 08-32)

A first order approximation for the frequency tuning of bending modes ignores torsional effects and established the regions of an airfoil that require change. Calculations of maximum kinetic and strain energies is described, and bending strain and potential energy equations are detailed. The various potential energies are added to give a resultant for each element, and potential energy increases in the same way that kinetic energy increases. The tuning method described was used for tuning two modes of a blade

simultaneously, and also allows a full-chord blade to be retained where previously the trailing edge had to be cut back. For a pin-fixed blade, the first bending moment was raised to 189 c/sec from 175 s/sec; the seconding mode was increased from 457 c/sec to 480 c/sec. The variation of frequency increase unit length with radius for both modes is shown, as is the required change in thickness to give the desired frequencies. M.W.R.

N68-17506# Southampton Univ. (England). Inst. of Sound and Vibration Research.
THE STODOLA METHOD APPLIED TO SANDWICH BEAM VIBRATION
D. J. Mead and S. Sivakumuran *In its* Numerical Method for Vibration Probl., Vol. 1 15 Jul. 1966 p 66–80 *ref* (See N68-17499 08-32)

A procedure is presented for calculating the natural frequencies and modes of sandwich beams in free flexural vibration where the effects of shear deformation can be of great importance. These effects were, therefore, included in an adaptation of the Stodola method of mode and frequency calculation that normally involves a four-fold integration of an initial approximate mode to obtain a better approximation to the mode. The integrations were carried out as matrix processes, and the overall process was used to formulate a dynamical matrix for the vibrating beam. The eigenvalues and eigenvectors of this dynamical matrix were determined by standard techniques on a digital computer. The integration processes were carried out using three different approximate integration rules, and the results from each were compared. Effect of varying the number of coordinates describing the transverse deflection of the beam was considered. The method was applied to a uniform simply-supported beam, a uniform cantilever, and a cantilever which tapers linearly in the form of a wedge. Comparisons were made between the frequencies calculated by these methods and the exact frequencies. Author

N68-17507# Southampton Univ. (England). Inst. of Sound and Vibration Research
NUMERICAL METHODS FOR VIBRATION PROBLEMS. VOLUME 2: STABILITY PROBLEMS—NON-LINEAR AND TRANSIENT VIBRATIONS
Jul. 1966 92 p refs Papers presented at the Symp., Southampton, England, 12–15 Jul. 1966

CONTENTS:

1. INSTABILITY IN THE INTEGRATION OF ORDINARY DIFFERENTIAL EQUATIONS P. A. Samet p 1–7 refs (See N68-17508 08-19)

2. INVESTIGATION OF STABILITY BY LIAPUNOV'S SECOND METHOD C. Storey (Loughborough Univ. of Tech.) p 8–25 refs (See N68-17509 08-23)

3. TRANSIENT RESPONSE OF A NON-LINEAR STEERING OSCILLATION F. D. Hales (Motor Industry Res. Assoc.) p 26–42 ref (See N68-17510 08-23)

4. NON-LINEAR STABILITY (SHIMMY) D. O. N. James (British Aircraft Corp.) p 43–54 refs (See N68-17511 08-32)

5. A SET OF COMPUTER PROGRAMMES TO CALCULATE THE FORCED RESPONSES OF FLEXIBLE AIRCRAFT C. G. B. Mitchell (Royal Aircraft Establish.) p 55–63 refs (See N68-17512 08-32)

6. OPTIMISATION TECHNIQUES IN THE SOLUTION OF NON-LINEAR VIBRATION PROBLEMS A. J. Sobey (Royal Aircraft Establish.) p 64–69 refs (See N68-17513 08-32)

7. TWO NUMERICAL METHODS FOR THE STABILITY OF EQUATIONS WITH PERIODIC COEFFICIENTS G. M. L. Gladwell and C. W. Stammers p 70–78 ref (See N68-17514 08-32)

8. THE STABILITY OF LINEAR DIFFERENTIAL EQUATIONS WITH PERIODIC COEFFICIENTS: AN APPLICATION OF FLOQUET'S THEOREM P. E. Williams (Royal Aircraft Establish.) p 79–83 refs (See N68-17515 08-23)

N68-17511# British Aircraft Corp., Weybridge (England).
NON-LINEAR STABILITY (SHIMMY)
D. O. N. James *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 2: Stability Probl.—Non-Linear and Transient Vibrations Jul. 1966 p 43–54 refs (See N68-17507 08-32)

Aircraft vibration associated with takeoff and landing or a stability problem dominated by nonlinearities was considered; and a linearized mathematical model was developed and stability was investigated with a flutter simulator and a digital computer. Determining the behavior of a rolling tire was an essential part of this shimmy investigation. Deformation of the rolling tire is shown, as is variation of shimmy speed with (1) torsional stiffness and bending stiffness and (2) vibration absorber frequency for a 64.4 lb weight. M.W.R.

N68-17512# Royal Aircraft Establishment, Farnborough (England). Structures Dept.
A SET OF COMPUTER PROGRAMMES TO CALCULATE THE FORCED RESPONSES OF FLEXIBLE AIRCRAFT
C. G. B. Mitchell *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 2: Stability Probl.—Non-Linear and Transient Vibrations Jul. 1966 p 55–63 ref (See N68-17507 08-32)

A set of computer programs were written to calculate the response of flexible aircraft to either harmonic or transient excitation by gusts or control movements. Aircraft flexibility was represented by a number of normal modes and unsteady aerodynamic effects can be included. Transient response to step excitation is obtained from the response to harmonic excitation by means of a Fourier transform technique. Practical calculations involve handling large quantities of data in digital form. To enable calculations to be made rapidly and accurately the amount of data prepared by hand must be kept to a minimum. Therefore the complete set of programs are integrated to allow the output from one stage to be used as input to the next. Translation programs are used to link complicated programs by other authors in the single calculation chain. An example of the results obtained using these programs is given, and possible applications to other dynamic systems are discussed. Author

N68-17513# Royal Aircraft Establishment, Farnborough (England).
OPTIMISATION TECHNIQUES IN THE SOLUTION OF NON-LINEAR VIBRATION PROBLEMS
A. J. Sobey *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 2: Stability Probl.—Non-Linear and Transient Vibrations Jul. 1966 p 64–69 refs (See N68-17507 08-32)

Non-linear vibration problems are solved by the use of optimization techniques on a suitable test function. By way of illustration, the sustained limit-cycle oscillations of a simply supported panel fluttering in a supersonic airstream were examined and a suitable test function was established. Three methods are described for conducting the optimization procedure on a digital computer. Author

N68-17514# Southampton Univ. (England). Inst. of Sound and Vibration Research.
TWO NUMERICAL METHODS FOR THE STABILITY OF EQUATIONS WITH PERIODIC COEFFICIENTS
G. M. L. Gladwell and C. W. Stammers *In its* Numerical Methods for Vibration Probl. Vol. 2: Stability Probl.—Non-Linear and Transient Vibrations Jul. 1966 (See N68-17507 08-32) p 70-78 ref

A perturbation technique and a transfer matrix method are discussed in terms of determining the stability of systems governed by equations with periodic coefficients. The first, which shows the location of each stability region and its approximate shape, provides insight into the behavior of the system; while the second gives purely numerical results. Detailed equations are included for both methods, including those for a more accurate transfer matrix using an eighth order Taylor series. M.W.R.

N68-17516# Southampton Univ. (England). Inst. of Sound and Vibration Research.
NUMERICAL METHODS FOR VIBRATION PROBLEMS. VOLUME 3: FINITE ELEMENT TECHNIQUES
Jul. 1966 70 p refs Papers presented at the Symp., Southampton, England, 12–15 Jul. 1966

CONTENTS:

1. THE FINITE ELEMENT METHODS AND ITS APPLICATION IN VIBRATION ANALYSIS O. C. Zienkiewicz (Univ. Coll. of Swansea) p 1–17 refs (See N68-17517 08-32)

2. FINITE ELEMENT TECHNIQUES APPLIED TO THE VIBRATIONS OF PLATE SYSTEMS R. D. Hewshell and G. B. Warburton p 18–25 ref (See N68-17518 08-32)

3. A STUDY OF FINITE ELEMENTS APPLIED TO PLATE FLEXURE G. A. Butlin and F. A. Leckie (Cambridge Univ.) p 26–37 refs (See N68-17519 08-32)

4. PLATE VIBRATION PROBLEMS USING THE FINITE ELEMENT METHOD WITH ASSUMED STRESS DISTRIBUTIONS AND TRIANGULAR ELEMENTS R. T. Severn and P. A. Taylor (Bristol Univ.) p 38–54 refs (See N68-17520 08-32)

5. STRUCTURAL VIBRATION ANALYSIS USING TRIANGULAR FINITE ELEMENTS M. Petyt p 55–64 refs (See N68-17521 08-32)

N68-17517# University Coll. of Swansea (Wales).
THE FINITE ELEMENT METHODS AND ITS APPLICATION IN VIBRATION ANALYSIS
O. C. Zienkiewicz *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 3: Finite Elem. Tech. Jul. 1966 p 1–17 refs (See N68-17516 08-32)

The finite element method is explained and compared with the finite difference method in the analysis of structural vibration problems. A simple example is given to illustrate the basis of the finite element approach. The general finite element displacement formulation is presented followed by a discussion of its applications to two dimensional stress analysis, non-structural problems, and the vibration of submerged structures. R.N.A.

N68-17518# Southampton Univ. (England). Inst. of Sound and Vibration Research.
FINITE ELEMENT TECHNIQUES APPLIED TO THE VIBRATIONS OF PLATE SYSTEMS
R. D. Henshell and G. B. Warburton *In its* Numerical Methods for Vibration Probl. Vol. 3: Finite Elem. Tech. Jul. 1966 p 18–25 ref (See N68-17516 08-32)

For vibration analysis certain box and shell type structures may be considered as a series of flat plates which may be divided into a number of finite elements of simple shape; convenient shapes are triangles and rectangles. In the present paper only rectangular elements are used. For relatively low frequencies the main effect is flexural; this work is concerned mainly with this type of deformation, but the effects of stretching are considered briefly; moreover small stretching and flexural deformations are uncoupled for the separate plate elements in a system. Author

N68-17519# Cambridge Univ. (England).
A STUDY OF FINITE ELEMENTS APPLIED TO PLATE FLEXURE
G. A. Butlin and F. A. Leckie *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 3: Finite Elem. Tech. Jul. 1966 p 26–37 refs (See N68-17516 08-32)

An element stiffness matrix has been obtained for plate flexure using compatible displacement fields. It is shown that it is necessary to add a fourth generalised displacement in addition to the three usual node displacements of normal displacement and two rotations. Author

N68-17520# Bristol Univ. (England).
PLATE VIBRATION PROBLEMS USING THE FINITE ELEMENT METHOD WITH ASSUMED STRESS DISTRIBUTION AND TRIANGULAR ELEMENTS
R. T. Severn and P. R. Taylor *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 3: Finite Elem. Tech. Jul. 1966 p 38–54 refs (See N68-17516 08-32)

In previous treatments of the problem of transverse vibration of plates by the finite element method, the mass and stiffness matrices for the elements were obtained on the basis of an assumed displacement distribution throughout the element and the shape of the element was restricted to a rectangle. In this treatment, the finite element method is used, but right angled triangular shaped elements are employed so that unusually shaped plates, which cannot satisfactorily be represented by an assemblage of rectangular elements, are brought within the ambit of the finite element method. For these triangular elements the stiffness matrix is obtained on the basis of assumed stress distributions within each element, and this has the advantage that slope continuity between elements can be preserved. In obtaining the mass matrices for the triangular elements displacement distribution is assumed throughout the element. Attention is also given to the problem of in-plane vibration and the necessary mass and stiffness matrices are derived for a right angled triangular element. Examples show that the methods give eigenvalues which converge, as the element size is reduced, to the known exact solution or to an accepted energy solution. Author

N68-17521# Southampton Univ. (England). Inst. of Sound and Vibration Research.
STRUCTURAL VIBRATION ANALYSIS USING TRIANGULAR FINITE ELEMENTS
M. Petyt *In its* Numerical Methods for Vibration Probl. Vol. 3: Finite Elem. Tech. Jul. 1966 p 55–64 refs (See N68-17516 08-32)

The displacement method of analysis was used to determine the vibration characteristics of both an unloaded and a loaded rectangular plate. A simple polynomial function which satisfied all the necessary requirements except continuity of normal slope was used in determining the element properties. The results showed satisfactory agreement when compared with the exact solution, and convergence obtained as the mesh was made successively finer. Author

N68-17522# Southampton Univ. (England). Inst. of Sound and Vibration Research.
NUMERICAL METHODS FOR VIBRATION PROBLEMS. VOLUME 4: THE EIGENVALUE PROBLEM
Jul. 1966 47 p refs Papers presented at the Symp., Southampton, England, 12–15 Jul. 1966

CONTENTS:

1. NUMERICAL METHODS FOR EIGENVALUE PROBLEMS G. M. L. Gladwell p 1–11 refs (See N68-17523 08-32)

2. ON THE GENERALISED EIGENVALUE PROBLEM C. A. Mercer p 12–18 refs (See N68-17524 08-32)

3. A PROPOSAL FOR THE INVERSION OF THE NORMAL MODE CALCULATION D. J. Roy (Brit. Aircraft Corp.) p 19–33 (See N68-17525 08-32)

N68-17523# Southampton Univ. (England) Inst. of Sound and Vibration Research.
NUMERICAL METHODS FOR EIGENVALUE PROBLEMS
G. M. L. Gladwell *In its* Numerical Methods for Vibration Probl. Vol. 4: The Eigenvalue Probl. Jul. 1966 p 1–11 refs (See N68-17522 08-32)

Iterative and transformation methods are described for eigenvalue problems. In the first category are methods aimed at

finding eigenvalues of the original matrix; while in the latter the matrix is first transformed into a simpler one, such as a triple diagonal matrix, and iterative techniques are then applied to find the eigenvalues. Transformation is usually best when a large number of eigenvalues are required. The matrix iteration method, which leads to the eigenvalue of the greatest modulus, is shown; as is the means of obtaining the eigenvalue of least modulus. The most important transformation methods make use of orthogonality to reduce the original matrix to a triple diagonal matrix; and methods of Givens, Householder, and Lanczos for symmetric matrices are discussed. Fundamental properties and use of a Sturm sequence, which involves the idea of a sign count function, are considered. M.W.R.

N68-17524# Southampton Univ. (England). Computation Lab.
ON THE GENERALISED EIGENVALUE PROBLEM
C. A. Mercer *In its* Numerical Methods for Vibration Probl. Vol. 4: The Eigenvalue Probl. Jul. 1966 p 12–18 refs (See N68-17522 08-32)

Methods for solving the generalized eigenvalue problem are considered under the restrictions that the A and B matrices are symmetric, large, and of band form; and that the B matrix is always positive definite. Direct evaluation, Sturm sequences, and transformation methods are detailed. Disadvantages of the direct evaluation are noted; for instance, unless the step size is small enough, it is possible to jump over a pair of roots. The Sturm sequences overcome many of these disadvantages. In order to develop the proposed transformation method, a matrix of quadratic form is reduced to one of canonical form. M.W.R.

N68-17525# British Aircraft Corp., Weybridge (England).
A PROPOSAL FOR THE INVERSION OF THE NORMAL MODE CALCULATION
D. J. Roy *In* Southampton Univ. Numerical Methods for Vibration Probl. Vol. 4 The Eigenvalue Probl. Jul. 1966 p 19–33 (See N68-17522 08-32)

The mathematical model and an example are presented of an attempted inversion process for normal mode calculation as encountered by the dynamicist in the aircraft industry. The model can represent motion of all or part of a flexible aircraft, and the lateral vibration characteristics were investigated for a super VC 10 cockpit in the 1-1/2 to 6 cps frequency range. The mathematical model consisted of the first four whole aircraft antisymmetric flexible normal modes containing appreciable front fuselage lateral displacement. Variations of the front and rear fuselage stiffnesses eventually produced quite a satisfactory result, but these occurred after an inversion approach to the problem was unsuccessful. Additional research is required to obtain specified normal modes and frequencies. M.W.R.

N68-17561*# Alabama Univ., University. Bureau of Engineering Research.
EXPERIMENTAL INVESTIGATION OF THE IMPACT CHARACTERISTICS ON NON-METALLIC MATERIALS Annual Report, Jun. 6, 1966–May 31, 1967
James L. Hill 15 Jul. 1967 26 p refs
(Contract NAS8-20346)
(NASA-CR-61569; AR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Characteristics of craters produced in targets of volcanic origin by aluminum projectiles are described. The targets are basalt and pumice in both solid and granular form. The projectiles are .308 caliber aluminum cylinders whose weights are between 12 and 30 grains and the projectile velocities are between 2500 and 5000 fps. The craters in the solid basalt are shallow and large in diameter. This is due to the shearing out of large spalls by the highly crushed material that is moving out from in front of the projectile. The solid pumice craters differ in that the highly crushed material in the central zone only crushes the pumice more around the central zone as it moves from in front of the projectile. This results in a crater that has a small entry hole that goes into a larger cavity. In the ground pumice (62–250 micron), the craters are double conical around a central burrow. Craters in finely ground basalt (62–250 micron) are nearly hemispherical at the bottom with very steep walls and have a slightly raised rim. Author

N68-17588*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
RESIDUAL-STATIC-STRENGTH AND SLOW-CRACK-GROWTH BEHAVIOR OF DUPLEX-ANNEALED Ti–8Al–1Mo–1V SHEET
I. E. Figgee Mar. 1968 29 p refs
(NASA-TN-D-4358) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Tests were conducted at room temperature on centrally cracked Ti–8Al–1Mo–1V duplex-annealed sheet specimens 2, 4, 8, and 20 inches wide. Tests were also conducted on specimens 8 inches wide in which cracks had been propagated either at various cyclic-stress levels or at various temperatures prior to static testing. The residual strength (based on net section prior to loading) for a given ratio of crack length to specimen width was less for wide specimens than for narrow ones. No effect of prior stress or temperature history on the residual static strength was found. The slow-crack-growth data obtained were approximated reasonably well by an equation of the form $a_c/a = 1 + A(w/2a - 1)^B$ where a_c is the half-length of the critical crack, a is the half-length of the initial crack, w is the specimen width, and A and B are constants which are determined empirically. Analysis of the residual-strength data by both the unified notch-strength analysis method and a modified version of this method is discussed. Author

N68-17592*# Aluminum Co. of America, New Kensington, Pa. Physical Metallurgy Div.
STUDY OF CRACK INITIATION PHENOMENA ASSOCIATED WITH STRESS CORROSION OF ALUMINUM ALLOYS Annual Report, 6 Jun. 1966–6 Jun. 1967
M. S. Hunter 28 Sep. 1967 179 p refs
(Contract NAS8-20396)
(NASA-CR-61562; AR-1) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Stress corrosion mechanisms in high strength aluminum alloys were investigated by a detailed analysis of factors which might affect crack initiation. Emphasis was on the relation of crack initiation sites to the internal metallurgical structure of the alloy. Factors external to the metal itself, such as surface roughness, surface film, and stress level, were also examined. Results so far indicate that the two most important factors in crack initiation are: (1) grain shape, structural directionality, and recrystallization, which control the orientation of corrosion susceptible boundary paths with respect to the stressing direction, and (2) the electrochemical relationships existing at boundaries which constitute these susceptible paths. Other factors appear to have no effect, although the formation of zones and precipitates accompanies the formation of the susceptible paths and probably has an indirect effect on the localized electrochemical relationships. R.N.A.

N68-17596# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
ON CONCENTRATED LOADS AND GREEN'S FUNCTIONS IN ELASTOSTATICS
Matias J. Turteltaub and Eli Sternberg Nov. 1967 107 p refs
(Contract Nonr-220(58))
(TR-13; AD-663574)

The investigation is concerned with the notion of concentrated loads in classical elastostatics and related issues. Following a limit treatment of problems involving concentrated internal and surface loads, the orders of the ensuing displacement and stress singularities, as well as the stress resultants of the latter, are determined. These conclusions are taken as a basis for an alternative direct formulation of concentrated-load problems, the completeness of which is established through an appropriate uniqueness theorem. In addition, the present work supplies a reciprocal theorem and an integral-representation theorem applicable to singular problems of the type under consideration. Finally, in the course of the analysis presented here, the theory of Greens functions in elastostatics is extended. Author (TAB)

N68-17635# United Research Services, Burlingame, Calif.
PROCEDURES FOR PREDICTION OF GROUND SHOCK PHENOMENA BASED ON ONE-DIMENSIONAL SHOCK PROPAGATION CONSIDERATIONS. EXPERIMENTAL STUDY OF LOADING-UNLOADING STRESS WAVE INTERACTIONS IN A SOIL SHOCK TUBE
J. V. Zaccor, D. F. Walter, and V. W. Davis May 1967 200 p refs
(Contract DA-22-079-ENG-488)
(URS-668-11; Rept.-2; AEWES-CR-3-171; AD-663830)

The report describes a definitive experimental study in which shock-induced square-wave pulses in soil were observed to give way to decaying pulse shapes, as in a gas shock tube, and rapid attenuation of peak stress occurred thereafter due to nonlinear propagation in the rarefaction. In the study three different duration pulses were applied to an 8-ft vertical column of granular material confined under boundary conditions leading to a stress-strain (Sigma - Epsilon) behavior described by d to the 2nd power Sigma/d Epsilon to the 2nd power > 0, i.e., a strain-hardening type of response. Applied stresses ranged from 50 to 500 psi. The report describes a simple modification to be applied to the prediction procedure described in the first report of this series in order to take into account, to a first approximation, the nonlinear propagation of unloading waves that occurs in real media because of nonlinear stress-strain behavior in the unloading branch. The procedure which predicts stress and motion histories based on the conservation laws, a measured constitutive relationship, and the applied pressure-time profile, is demonstrated by predicting the entire sequence of an experimentally observed square-wave pulse transformation into a decaying pulse. Author (TAB)

N68-17651*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLUTTER OF BUCKLED, SIMPLY SUPPORTED, RECTANGULAR PANELS AT SUPERSONIC SPEEDS
Robert W. Fralich and John A. McElman Washington Mar. 1968 17 p refs
(126-14-02-24-23)
(NASA-TN-D-4357) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A theoretical flutter analysis is presented for buckled, simply supported panels subjected to supersonic flow over one surface. The analysis employs the Von Karman large-deflection plate theory and linearized static aerodynamic strip theory. A Galerkin procedure using four static mode shapes is employed to determine a set of differential equations which is programed on an analog computer. The character of the output of the analog is used to determine the flutter speed. Results are obtained for panels with ratios of length in the streamwise direction to length in the cross-flow direction equal to 1/2 and 1 for three specified in-plane edge-loading conditions. An assessment of effects of cross-flow coupling of the modes is made by comparison of the results with those obtained when cross-flow coupling between the modes is neglected. Author

N68-17679# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. Dept. of Mechanics.
SELECTED ROOTS OF THE SYMMETRIC RAYLEIGH-LAMB EQUATION
Peter J. Torvik and Jay J. McClatchey 1967 77 p refs
(AFIT-TR-67-2; AD-663918)

Report contains roots for the symmetric Rayleigh-Lamb frequency equations. Real, imaginary and complex roots are given for a range of frequencies. Author (TAB)

N68-17683# Library of Congress, Washington, D. C. Aerospace Technology Div.
THEORY OF PLATES AND SHELLS IN FLIGHT-VEHICLE DESIGN
Victor Klein *in its* Foreign Sci. Bull., Vol. 4, No. 2 Feb. 1968 p 65-84 refs (See N68-17681 08-34)

Theoretical investigations by Soviet scientists in the theory of thin plates and shells, which are concerned with the design for strength and stability of the plate- and shell-like structural members of flight vehicles and of their engines and which indicate the state of the art in this field, are reviewed. Author

N68-17689# Department of Forestry, Vancouver (British Columbia). Forest Products Lab.
A NUMERICAL METHOD FOR STRESS ANALYSIS IN WOOD
C. K. A. Stieda Oct. 1966 32 p refs
(VP-X-8)

In the general theory of elasticity, it is shown that for elastic materials certain relationships exist, called stress functions, which relate the external loading, applied to a structural component, to the stresses produced in the member by these loads. These stress functions are obtained by integrating a fourth order partial differential equation. For certain problems solutions of this partial differential equation have been obtained by approximate solution. This method requires the solution of a large number of linear equations. The availability of high-speed digital computers has made it possible to use such numerical methods for the analysis of stresses. The purpose of this report is to present the basic equations required for the numerical analysis of wood, together with some recently obtained results. Author

N68-17692# Department of Forestry, Vancouver (British Columbia). Forest Products Lab.
STATIC FATIGUE OF WOOD UNDER CONSTANT STRAIN
Lars Bach Sep. 1967 7 p refs
(VP-X-24)

Static fatigue failure has been observed in stress-relaxation studies on woody tissues. Reported here is the empirical data obtained in preliminary stress-relaxation experiments conducted on 40 specimens at a relatively high constantly kept strain. The specimens used were tangential cut spring and latewood tissue of Douglas-fir and Norway spruce wood of 0.1×2.5×80 mm in dimensions; their moisture content was eight per cent and temperature 22°C. The grain orientation of specimens was parallel to the longitudinal axis of each piece. The specimens were strained to 90 percent of the estimated ultimate strain and then were permitted to stress relax at constant strain. The 100 percent strain level was obtained on matched control specimens loaded to failure with the strain rate 0.003 cm per cm per minute. The coefficient of variation was approximately six percent. Catastrophic failure was observed in more than half of the stress-relaxing specimens before 1,000 minutes had elapsed. Author

N68-17693# Department of Forestry, Vancouver (British Columbia). Forest Products Lab.
A SHEAR STIFFNESS FACTOR FOR PLYWOOD BOX BEAMS
C. K. A. Stieda Dec. 1967 15 p refs
(VP-X-31)

An equation is derived for the shear deflection of plywood box beams. Shear stiffness coefficients are calculated for beams with plywood webs having different proportions of veneer parallel and perpendicular to the span of the beams. It is concluded that, for practical engineering calculations, it is sufficient to assume a solid web when computing the deflection due to shear stresses.
Author

N68-17713# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF IMPULSES ON DEVELOPMENT OF INITIAL CRACKS [O VLIYANII IMPUL'SOV NA RAZVITIYE NACHAL'NYKH TRESHCHIN]
G. P. Cherepanov *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 153–161 refs (See N68-17701 08-23)

A solution for the nonstationary problem of expansion at constant speed of a rectilinear crack in an uniform stress field perpendicular to the crack line is applied to the influence of tensible stress impulses perpendicular to the line of crack. Considered is a case in which the impulse length of constant stresses is greater than the linear dimension of the initial carck, and where the length of the crack after impulse passage is greater than the length of the initial crack. The crack length after impulse passage is determined by multiplying the crack propagation speed with the pulse length. This article considers also the flat nonstationary deformation problem of rectilinear crack expansion due to short stress impulses perpendicular to the line of crack for the case in which the length of crack after impulse passage is greater than the length of the initial crack.
Author

N68-17714# Air Force Systems Command, Wright Patterson AFB, Ohio. Foreign Technology Div.
MACROSTRESS OF ELASTIC BODY [MAKRONAPRYAZHENIYA UPRUGOGO TELA]
M. Ya. Leonov and K. N. Rusinko *In its* J. of Appl. Mech. Tech. Phys., No. 1, 1963 14 Apr. p 163–173 refs (See N68-17701 08-23)

In view of presence of microdefects and microheterogeneity in real solid bodies, their deformation in a fairly small volume is accidental in nature. The mathematical expectation of these deformations is determined by methods of mathematical theory of elasticity and plasticity. By virtue of statistical laws, the relative shifts of points on a real solid body can be considered for practical purposes to coincide with shifts of corresponding points on a uniform model, provided the distance between them exceeds a certain magnitude, which is the structural characteristic of material. In the given article it is assumed that the total effect of microheterogeneities of a real solid body enclosed inside any sphere is the same. For this reason there are introduced certain averaged deformations of the sphere radius and to them are applied depencencies established during conventional mechanical tests on materials. Thus is attained the simplest generalization of Griffiths' theory of brittle rupture under slightly changed conditions at which plastic flow occurs.
Author

N68-17715# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
APPRAISAL OF RESISTANCE TO PROLONGED DESTRUCTION AND CERTAIN PECULIARITIES OF DEFORMATION IN A COMPLICATED TENSE STATE [OTSENKA SOPROTIVLENIYA DLITEL'NOMU RAZRUSHENIYU I NEKOTORYYE OSOBENNOSTI DEFORMIROVANIYA PRI SLOZHNOM NAPRYAZHENNOM SOSTOYANII] SOSTOYANII]
I. I. Trunin *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 175–181 refs (See N68-17701 08-23)

Given are certain test results on prolonged durability during torsion and extension of tubular samples prepared from superheated steam pipes of perlitic and austentic steels. Considered is the estimated resistance to prolonged destruction in a complicated state of strain from results of corresponding tests of uniaxial extension that used the biggest normal stress and the criterion of half stress intensity. Tests on long-term durability for each steel tubular samples included: (1) uniaxial extension; (2) pure torsion; and (3) joint action tensile and torsional forces. Test results are given.
Author

N68-17716# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FLAT FLOW OF HARD-PLASTIC MEDIUM IN WELL LUBRICATED LONG CHANNEL [PLOSKOYE TECHNIYE ZHESTKO-PLASTICHESKOY SREDY V KHOROSHO SMAZANNOM DLINNOM KANALE]
O. D. Grigorev *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 183–186 refs (See N68-17701 08-23)

Considered is the flow in a convergent, long, ideally smooth channel. Construction of channel profiles and the determination of flow parameters can be reduced to a well tabulated integral of probability in a complex plane. At the channel outlet, both the speed and stresses are parallel to the axis of the channel. This enables one, for a narrow outlet, approximately to satisfy the boundary conditions. Equations for the flat flow of a hard-plastic body in coincidence flow with trajectories of a large main stress have been formed.
Author

N68-17718# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
COMPRESSIBILITY OF GROUNDS UNDER DYNAMIC LOADS [O SZHIMAYEMOSTI GRUNTOV PRI DINAMICHESKIKH NAGRUZKAKH]
G. M. Lyakhov *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 193–199 refs (See N68-17701 08-23)

Considered are the results of experimental investigations on the dependence of blast wave front speed and maximum pressure exerted in sandy grounds at various humidities. Studied is the character of the relationships during explosive loads.
Author

N68-17719# Air Force Systems Command, Wright Patterson AFB, Ohio. Foreign Technology Div.
ACTION OF LONG SHOCK WAVES ON A SOLID BODY [O DEY'TVII DLINNYKH VDARNYDH VOLN NA TVERDOYE TELO]
S. S. Grigoryan *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 201–204 (See N68-17701 08-23)

During passage of a shock wave past an obstacle of limited dimensions there occurs a complicated diffraction pattern and the obstacle experiences nonstationary loads which are difficult to determine. However, in a case in which obstacle dimensions are small as compared to wave length, the problem is simplified and permits a comparatively full analysis. For that case the process of nonstationary wave influence on the body may be broken up into

two stages. At the first stage occurs reflection and diffraction of the shock wave and essentially nonstationary pressure distribution is created on the body. This stage, however, is comparatively short, since fronts of reflected and diffracted waves quickly depart from the body and nonstationary perturbations carried by them are damped. After that starts the second, more prolonged stage, when the body is subjected to a gas flow with slowly changing parameters. Author

N68-17735# Massachusetts Inst. of Tech., Cambridge.
SURFACES FOR COMPUTER-AIDED DESIGN OF SPACE FORMS Technical Report, Jul. 1965–Jun. 1967
Steven A. Coons Jun. 1967 110 p refs
(Contracts Nonr-4102(01); AF 33(600)-42859; Proj. Mac)
(MAC-TR-41; AD-663504) CFSTI: HC $3.00/MF $0.65

The design of airplanes, ships, automobiles, and so-called sculptured parts involves the design, delineation, and mathematical description of bounding surfaces. A method is described which makes possible the description of free-form doubly curved surfaces of a very general kind. An extension of these ideas to hyper-surfaces in higher dimensional spaces is also indicated. This surface technique has been specifically devised for use in the Computer-Aided Design Project at M.I.T., and has already been successfully implemented here and elsewhere. Author (TAB)

N68-17777# Naval Research Lab., Washington, D. C.
EFFECT OF SIDE GROOVES AND FATIGUE CRACK LENGTH ON PLANE-STRAIN FRACTURE TOUGHNESS
C. N. Freed 7 Dec. 1967 20 p refs
(NRL-6654; AD-663884)

An investigation was made to determine the effect of side grooving on plane-strain fracture toughness K sub Ic values obtained with smooth single-edge-notched tension specimens. In most cases the smooth and side-grooved values differed by only plus or minus 1 to plus or minus 3% for high strength steels and alloys of titanium and aluminum. The side-grooved specimens tended to slightly underestimate K sub Ic. Side grooves accentuate the displacement due to crack instability on the load-displacement record and permit K sub Ic values to be computed for specimens in which detection of crack initiation could not otherwise be made. The specimen is likely to fracture at or near maximum load when side grooves are employed. For the specimen geometry used in this investigation it has been determined that fatigue cracks of 0.05 in. and less in length cause the K sub Ic values for side-grooved specimens to be overestimated. There seems to be no relationship between the length of the crack, below 0.05 in., and the amount by which K sub Ic is increased. Author (TAB)

N68-17785# Hydronautics, Inc., Laurel, Md.
EXPERIMENTAL STUDY OF A LOW MODULUS FLUTTER MODEL FOR STRUT-FOIL-POD CONFIGURATIONS
T. T. Huang Jul. 1967 38 p refs
(Contract Nonr-4293(00))
(TR-459-2; AD-663896)

The results of an experimental investigation of three low modulus built-up struts with several rigid pods and foil configurations are presented. The scaled model struts were constructed using a copper alloy spine coated with an extremely low modulus silicone rubber. The spine and coating of the flutter models were designed so that the elastic axis, the center of gravity, the ratio of torsional stiffness to bending stiffness and the mass density match those of the aluminum Grumman No. 3 strut. The modulus of the model was reduced to scale the model flutter speed at about 1/4 that of the prototype. The rigid pod and foil were hydrodynamically similar to the E configuration. The tested results of the low modulus strut are in good agreement with the scaled values from the prototype. In addition, a series of flutter tests were conducted to study the effects of strut sweep angle, strut submergence, pod weight and foil angle of attack and dihedral on the flutter characteristics of the strut. Author (TAB)

N68-17787*# Utah Research and Development Co., Inc., Salt Lake City.
STUDY OF CRATER EFFECTS IN LOW DENSITY SURFACES Final Report
[1967] 41 p refs
(Contract NASw-1196)
(NASA-CR-93294) CFSTI: HC $3.00/MF $0.65 CSCL 20K

In order to explore the possibility of capturing meteoritic material during collisions involving meteorites and a low density surface, a light-gas gun was used to accelerate gold impregnated, epoxy projectiles into targets of lead, hard and soft aluminum, and rigid polyurethane foams of various densities at velocities of about 6 km/sec. By analyzing the craters formed by these projectiles with a crystal scintillation counter, it was found that only about 2% of projectile remained in lead and aluminum targets, and between 30% and 40% in the soft aluminum. The projectile left in the foam crater is inversely proportional to target density. Details are given on the experimental methods used to measure energy, velocity, and mass of material ejected from craters formed in the foams. Energy associated with a fraction of the material coming from the crater was measured along with the average velocity of projected material. Results show that most of the ejected material leaves the target at angles of 40° to 60°, and that most of the energy associated with this material is also found at these angles. B.S.D.

N68-17840# Naval Research Lab., Washington, D. C.
BASIC ASPECTS OF CRACK GROWTH AND FRACTURE Final Report
G. R. Irwin, J. M. Krafft, P. C. Paris (Lehigh Univ.), and A. A. Wells (Queens Univ., Belfast) 21 Nov. 1967 82 p refs
(NRL-6598; AD-663882)

A near approach to absolute fracture safety in boiling water (BW) and pressurized water (PW) nuclear reactor pressure vessels requires a very conservative fracture control plan. Such a plan must assume that any plausible cracklike defect, which has not been proved absent by inspection, may exist in the vessel. Requirements for design, materials, and inspection may then be established in a conservative way relative to estimates of progressive crack extension behavior. These estimates are assisted by elastic and plastic methods of analysis of cracks in tension. Approximate methods of assigning K sub Lc values to measurements of crack toughness in terms of a brittle-ductile transition temperature are valuable in reviewing methods of fracture control which have received trial in the past, such as the NRL fracture analysis diagram and the leak-before-break toughness criterion. Author (TAB)

N68-17913# Southwest Research Inst., San Antonio, Tex. Dept. of Mechanical Sciences.
INVESTIGATION OF WATER IMPACT OF BLUNT RIGID BODIES—REAL FLUID EFFECTS
C. Richard Gerlach 29 Dec. 1967 46 p refs
(Contract N00014-67-C-0213)
(TR-1; AD-663893)

The results of an experimental investigation of the importance of air density and other real fluid properties to water impact of small, blunt, rigid bodies are given. Assuming peak impact pressure to be the dependent variable, the significant fluid properties were found to be liquid density, liquid sonic velocity, gas density and probably to some extent, gas kinematic viscosity. The test results indicate that even for low velocity impact, where air compressibility is a principal factor, acoustic propagation in the water needs consideration and should not be neglected without justification. A

limited amount of testing was also done to determine the effect of liquid surface waves and the restriction of airflow upon impact pressures. Finally, high-speed motion pictures were taken that showed the surface disturbance during impact. Author (TAB)

N68-18069*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
ANALYSIS OF THE BUCKLING PROCESS OF CIRCULAR CYLINDRICAL SHELLS UNDER AXIAL COMPRESSION
R. C. Tennyson and S. W. Wells Feb. 1968 47 p refs
(NASA-CR-66553; UTIAS-129) CSCL 20K

Geometrically 'near-perfect' circular cylindrical photoelastic shells having radius-to-thickness ratios of the order 100≈400 have been tested in pure axial compression. The critical buckling loads were found to agree within 10≈14% of the classical value, or within a few percent of the reduced buckling load taking into account the clamped end constraint. High speed photographs of the buckling process were obtained using two cameras viewing the change in the 45 isoclinics over the entire cylinder's length and over 60% of the cylinder's perimeter. A theoretical analysis of the inception of buckling using Koiter's mode shapes has demonstrated that the classical buckling mode was observed in the experiments for the first time. Further investigation of the nonlinear postbuckling mode shapes just after initial buckling has predicted the wave forms observed. It was also determined that the shallow shell equations used to describe the large-deflection postbuckling behavior do not predict isoclinic patterns which are observed in the later stages of buckling. Consequently it is concluded that postbuckling load calculations based on these equations are inaccurate beyond the early stages of buckling. Author

N68-18077# ARA, Inc., West Covina, Calif.
RESEARCH ON ENERGY ABSORBING STRUCTURES, PART 5 Annual Report, 1 Feb. 1966–31 Jan. 1967
Bernard Mazelsky, Sheng-Rong Lin, and T. H. Lin Mar. 1967 142 p refs
(Contract AF 49(638)-1521)
(ARA-88; AFOSR-67-2484; AD-663434)

The present program was concerned with extending the theory of large-deflection behavior of plate and shell structures to very-large-deflection-behavior wherein the principal effect to be considered was to account for the moment-arm correction for the load when the structural deflection becomes very large. Although attempts were made to analyze both plate and curved shell structures, the present analysis in terms of numerical evaluation was limited to flat plate structures. Detailed experiments were conducted for both the flat plate and the curved shell in order to obtain correlation of the flat plate numerical results as well as obtain some physical insight into the curved shell problem. A complete description of the low cycle fatigue torsion tester, which has been modified from a NASA contract to include axial tension and compression, is described. Preliminary tests were conducted on 347 stainless steel and two types of aluminum specimens. Preliminary results indicate that the effects of axial tension and compression previously found for low strain values (high cycle fatigue) for the 347 stainless steel and 24 ST aluminum specimens do not necessarily agree with those trends found at low cycle fatigue. However, the effects of tension and compression on low cycle torsion fatigue for the 1100 aluminum specimens do appear to be significant. Author (TAB)

N68-18129*# California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.
DELAYED FRACTURE IN VISCOELASTIC-PLASTIC SOLIDS
Milosz P. Wnuk and Wolfgang G. Knauss Mar. 1968 50 p refs
(Grant NsG-172-60)
(NASA-CR-93354; GALCIT-SM-68-8) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The time dependent and path dependent processes occurring prior to fracture in the regions close to the crack tip were considered for an axially symmetrical geometry. To account for nonlinear behavior of glasslike high linear polymers within the localized zones of high stress and to describe the rheological response of the bulk material, a model is developed, which postulates that the crack is surrounded by a Dugdale-type thin plastic zone, while the less stressed matrix is assumed to behave as a linear viscoelastic solid. Several cases of creep failure, under different histories of loading, are discussed. In particular, a universal equation for creep failure under step-load condition is derived. It relates the tensile strength to the time of application of the load and material characteristics. Author

N68-18183*# Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Mechanical Engineering.
ANALYSIS OF NOTCHES AND CRACKS: PROGRESS IN PILOT COMPARISONS BETWEEN EXPERIMENT AND THEORY
J. L. Swedlow Dec. 1967 36 p refs
(Grant NGR-39-002-023)
(NASA-CR-66570; SM-8) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Three preliminary studies in progress to assess the correlation to be expected between elastic-work-hardening-plastic continuum theory and experiments are reviewed. Consideration is being given to required accuracy of the specification of the stress-strain curve and appropriateness of assumption of small strains and rotations in the theory. A previously developed finite element computer program is being used, and experimental data has been obtained from other laboratories. The studies include plastic deformation about an initially round hole cross-bored through a 2024-T35 aluminum alloy rod subjected to pure twist, local behavior in plane strain near a crack tip in a thick plate, and thickness reduction in plane stress near a crack tip in a thin sheet. These studies are intended to provide the experience required to evaluate adequately a sophisticated finite difference computer program for elastic-work-hardening-plastic analysis of solids containing notches or cracks. The development of such a program is in progress. Author

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N68-17254# Sandia Corp., Albuquerque, N. Mex. Aerospace Nuclear Safety Dept.
REENTRY TEMPERATURES OF LOW HEAT CAPACITY STRUCTURES
Robert D. Klett Aug. 1967 143 p refs
(SC-RR-67-232) CFSTI: HC $3.00/MF $0.65

Equations are derived for computing the temperatures of low heat capacity structures during reentry for free molecule and continuum flow. These equations were solved for altitudes from 0 to 700,000 feet, velocities from 600 to 38,000 fps, initial temperatures from 500 to 1500°R, and for all expected values of dimensionless groups, which include thermal emissivities and heating ratios. The results are presented in graphical form. The uses and limitations of these graphs for analyzing reentering structures are discussed. Author (NSA)

N68-17286*# Aerojet-General Corp., Azusa, Calif.
A HEAT TRANSFER INVESTIGATION OF EJECTOR SYSTEMS WITH 90° TURNS. NERVA PROGRAM
G. O. Patmor, R. E. Nelson, B. Mandell, and B. L. McFarland (Rocketdyne, Canoga Park, Calif.) Nov. 1964 25 p refs
(Contract SNP-1)
(NASA-CR-91274; RN-DR-0038; TID-23652) CFSTI: HC $3.00/MF $0.65 CSCL 21B

Results are presented from a test program that evaluated the heat transfer characteristics of a series of ejector systems that turned the rocket exhaust gases through 90°. A series of tests with heated nitrogen was made for each ejector, during which measurements of local pressures and wall temperatures were made to provide the data necessary to evaluate the heat-transfer conditions. The results from three of these systems are discussed to illustrate the differences in thermal behavior that can be obtained during the turning of the gases. The maximum heating rate was reduced by a factor of 7 when the ejector had a long radius, as compared to a short radius 90° turn and by a factor of 5 by permitting the gases to shock down to subsonic flow prior to entering the short radius bend. A method of converting the scale-model heat-transfer coefficient data to any other scale size, working fluid, nozzle chamber temperature or chamber pressure and an empirical correlation of the maximum heating rates is presented.
Author (NSA)

N68-17305# Explosives Research and Development Establishment, Waltham Abbey (England).
THE THERMAL EQUILIBRIUM OF WIRES IN HOT GAS STREAMS
K. N. Bascombe 16 Aug. 1966 28 p refs
(ERDE-TM-11/M/66; WAC/174/012)

The thermal equilibrium of wires in hot gases is discussed, both generally and as applied particularly to thermocouples. The estimation of the radiation correction is considered, with special reference to methods available for determining the emissivity of a metal wire coated with silica to eliminate catalytic effects. In the case of a silica-coated platinum/platinum-rhodium thermocouple, three different methods are shown to give concordant results for the emissivity. Formulae are presented by which the correction may be estimated.
Author

N68-17321# Weapons Research Establishment, Salisbury (Australia).
MECHANISM OF AMMONIA OXIDATION IN SHOCK WAVES. PART 2: WITH NITROUS OXIDE
L. J. Drummond and S. W. Hiscock Jul. 1966 18 p refs
(WRE-TN-CPD-114)

Measurements have been made of the speed of reflected shocks in mixtures of argon and nitrous oxide. The results are considered in relation to the kinetics of the decompositon reaction which was studied using absorption spectroscopy at temperatures between 1650° and 1950°K. Comparable observations were made when ammonia was added as a fuel. The presence of OH and NH radicals was confirmed, and this provides information on the nature of the reactions leading up to explosion of the nitrous oxide—ammonia mixture which occurs with a negligible induction period at 1850°K.
Author

N68-17326# Iowa State Univ. of Science and Technology, Ames.
HEMISPHERICAL SPECTRAL EMITTANCE OF THULIUM OXIDE
R. K. Stewart, W. R. McMahon, and D. R. Wilder Oct. 1967 16 p refs
(Contract W-7405-ENG-82)
(IS-1688) CFSTI: HC $3.00/MF $0.65

Hemispherical spectral emittance values, ranging between 0.7 and 0.8, are given for Tm_2O_3 at 2300 to 3000°K. In this interval emittance is linear with respect to temperature and is nearly horizontal. A carbon arc image furnace and a photocell detector were employed to obtain the data reported.
Author (NSA)

N68-17486# Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Strahlantriebe.
FLOW INVESTIGATIONS COMBUSTORS WITH AERODYNAMIC FLAME STABILIZATION. PART 2: PREHEATED FLOW [STROEMUNGSUNTERSUCHUNGEN IN BRENNRAEUMEN NIT AERODYNAMISCHER FLAMMHALTUNG. TEIL 2: VORGEHEIZTE STROEMUNG]
Walter Alvermann and Rolf Ulken 5 Sep. 1967 29 p refs
In GERMAN; ENGLISH summary
(DLR-FB-67-77, Pt. 2)

The report is a continuation of the investigations about measurements of the flow direction in gases presented in DLR-report 67-36. The straight and the swan-neck five-tube probes were used again in a rectangular channel into which from the narrow-sides jets of compressed air injected with an angle against the flow which was preheated to about 670°K. The determined direction fields and velocity fields are compared with the results gained from the cold flow.
Author

N68-17544# Lockheed Missiles and Space Co., Sunnyvale, Calif.
MEASUREMENT OF THE THERMAL PRESSURE IN A SUBSTANCE HEATED BY LASER RADIATION
B. N. Abashkin, A. A. Kalmykov, and Iu. E. Pleshanov 1967 8 p refs Transl. into ENGLISH from Prikl. Mekh. i Tekh. Fiz. (USSR), no. 5, 1967 p 107–110

The possibility is shown of finding the equation of state of a material in the $p = p_0$ domain by means of thermal pressure measurement during heating by laser radiation. The developed piezoelectric method allows determination of the value of the Gruneisen coefficient for heat paraffin, which is in good agreement with the data obtained by other means.
Author

N68-17566*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
BOILING HEAT TRANSFER COEFFICIENTS, INTERFACE BEHAVIOR, AND VAPOR QUALITY IN ROTATING BOILER OPERATING TO 475 G's
Vernon H. Gray, Paul J. Marto, and Allan W. Joslyn (NASA, Manned Spacecraft Center, Houston, Tex.) Washington Mar. 1968 41 p refs
(NASA-TN-D-4136) CFSTI: HC $3.00/MF $0.65 CSCL 20M

An experimental heated-wall rotating boiler was investigated with continuous through-flow water as the test fluid. Heat-transfer coefficients were obtained with the boiler stationary and at rotative accelerations to 200 g's. Heat fluxes up to 505,000 Btu per hour per square foot were employed in obtaining the coefficients. Photographic and boiler-performance data were obtained to 475 g's. Outlet vapor quality, measured by throttling calorimeters, varied from above 99 percent to several degrees of vapor superheat. High-speed motion pictures revealed that high accelerations nearly eliminated disturbances at the liquid-vapor interface, reduced the number and size of bubbles, and promoted direct evaporation across the interface by the mechanism of convective secondary-flow cells in the rotating fluid annulus. Boiling heat-transfer coefficients at low heat fluxes were increased by increases in acceleration. At high heat fluxes the opposite was true, although the variation in coefficient was small and comparable with that caused by surface conditioning and aging effects. The crossover points for the coefficients occurred at progressively higher heat-flux levels as acceleration was increased. A boiling heat-transfer coefficients as high as 9000 Btu per hour per square foot per °F was measured (at the highest heat-flux value). Boiler-test performance was quite satisfactory and warranted consideration of the rotating boiler concept in Rankine cycle systems for power generation.
Author

N68-17708# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MOVEMENT OF A GAS UNDER THE ACTION OF A CONCENTRATED IMPACT ON ITS SURFACE (DURING AN EXPLOSION ON THE SURFACE)

Yu. P. Rayzer *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 81–102 refs (See N68-17701 08-23)

The movement of a gas is considered, which in the beginning occupies a half-space bordering on emptiness, and which is then under the action of concentrated and scattered impacts on its surface or under localized and scattered surface explosions. The concentrated impact problem serves as an idealized model by describing the initial shock wave propagation speed of a falling meteorite toward the surface of a planet, or the impact of a micrometeorite on the surface of an artificial satellite. It is a two-dimensional analog for a known plane problem of transient impact. The qualitative movement is described and the total limitation on the index of automodelness n in the law of attenuation of a shock wave) is established. Approximate problem solutions are generalization for two-dimensional solutions of a one-dimensional plane problem. For a concentrated impact we obtained $n = 1.07$ at an adiabatic line index $\gamma = 1.205$. For scattered impact $n = 1.14$ at $\gamma = 1.266$. Author

N68-17709# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CONCERNING THE STABILITY OF THE BURNING REGIME OF A POWDER IN A SEMICLOSED SPACE

Ya. B. Zel'dovich *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 103–124 refs (See N68-17701 08-23)

An analysis of the burning stability of a powder usually starts from the given dependence of the burning velocity on the pressure. During rapid pressure changes the burning velocity may differ from its steady-state value. In order to determine the steady-state velocity after a pressure change, it is necessary that the heated layers of powder have time to reform. During a rapid pressure change in a small chamber volume at low pressure, when the characteristic hydrodynamic pressure-change time is less than the burning time of the heated layer, a loss in stability may occur. A mathematical analysis is given with the very simple assumption of the absence of sound waves in the chamber. The stability of steady-state burning of a powder in a semiclosed space is examined theoretically by the method of small perturbations, taking into account the temperature distribution in the powder, the effect of this distribution on the burning velocity, and the relation between the burning velocity and the pressure. The burning is shown to be unstable at low pressures. A criterion, depending on the free volume of the chamber and on the area of the critical cross section of the nozzle, is given for conditions of stability. Author

N68-17710# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EFFECT OF INJECTING GASES INTO TURBULENT FRONTIER LAYER WITH LONGITUDINAL PRESSURE GRADIENT ON RESISTANCE OF FRICTION [VL'YANIYE VDUVA GAZOV V TURBULENTNYY POGRANICHNYY SLOY S PRODOL'NYM GRADIENTOM DAVLENIYA NA SOPROTIVLENIYE TRENIYA]

P. N. Romanenko and V. N. Kharchenko *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 125–134 refs (See N68-17701 08-23)

Analyzed is porous cooling by blowing different coolants into the turbulent boundary layer on a flat plate during longitudinal flow around it without pressure gradients in the flow direction. Obtained are the basic dynamic characteristics for the turbulent boundary layer on a porous flat plate during longitudinal flow around it by heated air with pressure increase and pressure lowering in the direction of the flow. Gases with different molecular weight—air, carbon dioxide, and freon-12—were blasted through the porous plate into an air flow. Author

N68-17721# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CONCERNING A DEVICE FOR THE DETONATION OF LIQUID EXPLOSIVES

A. N. Dremin, O. K. Rozanov, and V. S. Trofimov *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 211–219 refs (See N68-17701 08-23)

A criterion is developed for the detonation of liquid nitromethane (NM) with an initial density of $\rho = 1.14$ g/cm^2. This means that the shock front of the detonation wave in NM is also rough. Calculation data used describe the shock adiabatic line of NM and the relation of the heat capacity of NM to temperature. The obtained value for T_1 was 2100°K. The value of the activation energy was obtained from measured speeds of detonation and the dimensions of heterogeneities on charges of NM and mixtures of NM, the length of which reached to 10 diameters. This means that all measured magnitudes refer to a stationary detonation. As the measurement showed, the speed of detonation falls with the increase of acetone concentration in the mixture. This leads to a lowering of the temperature behind the shock front of a detonation wave and an increase of reaction time. The dimensions of the heterogeneities in this case are increased. Author

N68-17722# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STATIONARY THEORY OF THERMAL SELF-IGNITION [K STATSIONARNOY TEORII TEPLOVOGO SAMOVOPLAMEN-

S. A. Kaganov *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 221–225 refs (See N68-17701 08-23)

The problem of thermal self-ignition is considered and by assuming that its reaction speed depends on temperature. If stationary temperature is established in a vessel, then thermal self-ignition does not occur; if the stationary distribution of temperature is impossible, then there is thermal self-ignition (explosion). The function $\phi(T)$ characterizes the reaction speed depending upon temperature and it is required to determine the regions in which the problem has a solution. With the help of very simple calculations it is possible to estimate the critical sizes for vessels of flat, cylindrical and spherical forms for a fairly general $\phi(T)$ by assuming that the function $\phi(T)$ is positive in $0, +\infty)$, continuous and monotonically increasing over this interval and continuously differentiable. Solutions are given. Author

N68-17723# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SOLUTIONS OF PROBLEMS OF THERMAL CONDUCTION FOR A COEFFICIENT OF HEAT RADIATION DEPENDING ON TIME [RESHENIYE ZADACH TEPLOPROVODNOSTI PRI KOEFFITSIENTE TEPLOOTDACHI, ZAVISYASHCHEM OT VREMENI]

Yu. L. Rozenshtok *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 227–230 refs (See N68-17701 08-23)

Solutions are given for problems of thermal conduction coefficients of heat radiation depending on time. The problems are solved by approximate integral method, linear first order differential equation, and an algebraic equation containing an unknown to the first power. Author

N68-17724# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THERMAL WAVES IN UNLIMITED SPACE WITH CYLINDRICAL CAVITY [TEPLOVYYE VOLNY V NEOGRANICHENNOM PROSTRANSTVE S TSILINDRICHESKOY POLOSTYYU]

A. A. Koshkin *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 231–234 (See N68-17701 08-23)

Considered is the heating of an infinite space with cylindrical cavity along which flows gas or liquid with a temperature variable. The initial temperature of the body is equal to zero. The heat exchange between surface and medium is determined by the heat radiation coefficient. It is required to find the temperature distribution along the radius of the body at any moment of time specific heat consumption. Author

N68-17725# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NONSTATIONARY HEAT EXCHANGE BY RADIATION FROM TWO OPAQUE GRAY BODIES [NESTATSIONARNYY TEPLOOBMEN IZLUCHENIEM DVUKH NEPROZRACHNYKH SERYKH TEL]

N. A. Rubtsov *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 235–242 refs (See N68-17701 08-23)

Considered is the nonstationary radiant interaction of two half-bodies. Approximate expressions for developing radiation density are obtained by using Tikhonov's solution on cooling of half-body during radiation into surrounding space at constant temperatures. Various equations are used to solve the problems in this article. Author

N68-17726# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

OSCILLATORY RELAXATION AND INTERACTION OF MOLECULES IN OXYGEN AT HIGH TEMPERATURES [KOLEBATEL'NAYA RELAKSATSIYA I VZAIMODEYSTVIYE MOLEKUL V KISLORODE PRI VYSOKIKH TEMPERATURAKH]

N. A. Generalov and S. A. Losev *In its* J. of Appl. Mech. and Tech. Phys., No. 1, 1963 14 Apr. 1967 p 243–252 refs (See N68-17701 08-23)

Absorption spectroscopy behind the front of a shock wave is used to measure the relaxation time of carefully purified oxygen over the temperature range 1200–6600°K. The known relationships of the Landau–Teller relaxation for the model of two colliding diatomic molecules determines the parameters of the potential intermolecular interaction. Author

N68-17797 Oak Ridge National Lab., Tenn. Reactor Div.

HEAT TRANSFER LIMITATIONS FOR DYNAMIC CONVERTERS

A. P. Fraas *In* AGARD Combust. and Propulsion 1967 p 111–134 refs (See N68-17793 08-03)

Heat transfer considerations are major limiting factors in the design, development, and operation of dynamic conversion systems for space power plants. The nature of these limitations varies with the component. For example, in the heat source–whether nuclear or solar–thermal conduction affects the thermal stresses, thermal distortion, and local hot spots. These factors are likely to limit the practicable power density in the heat source to a lower value than might be permitted by the obvious problem of heat transfer from the heated solid surface to the fluid cooling it. The latter is likely not to be a difficult problem except for local hot spots caused by poor flow distribution or the like. Other heat transfer limitations include problems in the boilers and condensers for Rankine cycle systems and heat conduction, emission, and reflection in the radiator. This paper presents some typical examples of these problems that are particularly likely to be determining factors in the design of turbine-generator space power plants. Author

N68-17895*# Massachusetts Inst. of Tech., Cambridge. Center for Space Research.

ELECTROCONVECTIVE INSTABILITY WITH A STABILIZING TEMPERATURE GRADIENT. 2: EXPERIMENTAL RESULTS

Robert J. Turnbull Feb. 1967 32 p refs

(Grant NsG-368)

(NASA-CR-93335; CSR-TR-68-4) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A uniform vertical electric field produces an instability in a poorly-conducting fluid subject to a vertical temperature gradient. A previous paper [1] presents the theory for this instability. Here measurements are made of the voltage at the threshold for instability. Since the instability occurs as an overstability, the frequency at the threshold was also measured. These results are in agreement with those predicted by the theory. Heat transfer experiments show a significant increase in heat flow under the influence of the electric field. Author

N68-17901*# Aztec School of Languages, Inc., Acton, Mass. Research Translation Div.

INFRARED RADIATION METHOD OF DETERMINING THERMAL DIFFUSIVITY, HEAT CAPACITY AND THERMAL CONDUCTIVITY OF SOLID MATERIALS

Koichi Ogawa Washington NASA Feb. 1968 21 p refs Transl. into ENGLISH from Tech. Rept. of Natl. Aerospace Lab. (Tokyo), TR-128, 1967 p 1–11

(Contract NASw-1692)

(NASA-TT-F-11453; TR-128) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Presented in a simple method of determining thermal diffusivity, heat capacity, and thermal conductivity of solid materials, along with some experimental results. These three thermal properties are determined for stainless steel, glass, bakelite, Japanese cypress, and fiberglass-reinforced plastics at near 20°C. It is shown that the thermal properties of nonmetallic solid materials are simply determined by this method and that their values are easily made available for practical applications. Author

N68-17929# Instituto Nacional de Technica Aeroespacial, Madrid (Spain).

DIFFUSION FLAMES AND SUPERSONIC COMBUSTION Final Report

I. Da-riva, E. Fraga, and A. Linan, and J. L. Urrutia 1 Oct. 1967 50 p refs

(Grant AF-EOAR-66-41)

(AFOSR-68-0066; AD-663741)

Some problems related to the fluid dynamical and chemical phenomena appearing near the injector exit of an idealized supersonic combustion burner, are theoretically investigated. The ignition delay length is calculated under the assumption that fuel(hydrogen) and oxidizer (air) mix without appreciable concentration change and heat release resulting from chemical reactions, although radicals, mainly atomic hydrogen, are produced. The chemical kinetics scheme is reduced to one overall chemical reaction. The presence of radicals introduced in the mixing zone from outside is taken into account. The fluid dynamic pattern corresponds to a two-dimensional constant pressure shear layer. It is shown that dissociation at the injector outer boundary layer controls in many cases the ignition delay length. Since when hydrogen is injected into a coflowing supersonic stream of air, a wake-like recirculating configuration appears, the ignition delay lengths were compared

with some experimental data on near wake lengths, to show that, in most cases of interest, recirculation would enhance the ignition mechanism. Author (TAB)

N68-17948# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
AN EXPERIMENTAL INVESTIGATION OF SHOCK INITIATED DETONATION WAVES IN A FLOWING COMBUSTIBLE MIXTURE Final Scientific Report, Jun. 1966–Jun. 1967
Leonard Anthony Hamilton (Ph.D. Thesis—Ohio State Univ.) ARL Oct. 1967 194 p refs
(ARL-67-0202; AD-663715)

The investigation was concerned with the initiation of detonation waves in a subsonically flowing mixture of gaseous hydrogen and oxygen by means of shock waves injected opposite to the direction of the flow. Nominally stoichiometric mixtures at near ambient pressure and stagnation temperature were flowed through a constant area tube at Mach Numbers of approximately .2, .5, and .8. The shock waves were produced by a simple shock tube driver employing helium and mylar diaphragms. Piezoelectric pressure transducers, thin film heat transfer gages, and ionization probes were used to measure the various wave velocities. Results showed that detonation waves can easily be produced in such a flowing mixture. The minimum incident shock wave Mach Number above which detonation always occurred was 2.12 for M(Exit) approx. = .2; 1.75 for M(Exit) approx. = .5; and 1.56 for M(Exit) approx. = .8. Author (TAB)

N68-18016# Department of Forestry, Ottawa (Ontario).
MECHANISM OF THERMAL DEGRADATION OF CELLULOSE: A REVIEW OF THE LITERATURE
G. David M. MacKay 1967 23 p refs *Its* Dept. Publ. No. 1201 (ODC-813.4) CFSTI: HC $3.00/MF $0.65

A detailed account and critical assessment is given of research on the thermal degradation of cellulose. Early and current theories of flame-proofing are described and discussed in relation to theories of thermal degradation. The contributions of the major current experimental approaches to the study of thermal degradation of cellulosic materials are described including "Thermal Gravimetric and Differential Thermal Analysis", "Infra-red Spectroscopy", "Gas Chromatography", "Paper Chromatography", and other forms of "Fraction Analysis". The productivitiy of each of these approaches in characterizing the phenomena involved and providing data for theoretical interpretation is assessed. Particular attention is given to analysis by the thermal gravimetric and differential thermal techniques since these techniques have been of particular usefulness in classifying the actions of fire retardants and identifying the roles that they play in modifying the processes involved in thermal degradation. A separate section is devoted to the "Levoglucosan Theory" in relation to which a large part of the work in this field has been done. Author

N68-18046*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
SELF EVACUATED MULTILAYER INSULATION OF LIGHTWEIGHT PREFABRICATED PANELS FOR CRYOGENIC STORAGE TANKS
Porter J. Perkins, Robert P. Dengler, L. R. Niendorf, and G. E. Nies Washington Mar. 1968 25 p refs
(NASA-TN-D-4375) CFSTI: HC $3.00/MF $0.65 CSCL 13D

A new concept for simplifying the application of radiation-shield insulation to cryogenic tanks was developed and tested for both ground and space performance. A vacuum-tight flexible casing of laminated aluminized Mylar encloses the multilayers, forming panels that are bonded to tank walls in an overlapping shingle arrangement. The panels, weighing only 0.34 pound per square foot (1.66 kg/m^2), are filled with carbon dioxide (CO_2) gas which cryopumps to provide required vacuum when the tank is filled with a cryogen. The thermal performance of this insulation was determined in flat-plate and cylindrical calorimeters. Of the many materials tested in the flat-plate calorimeter, polyurethane foam was chosen as the separator between radiation shields because of its small increase in heat flux when compressed to 14.7 psi (10.13 N/cm^2) in panels evacuated in the atmosphere. During ground tests, insulation panels as large as 3 by 6 feet (0.91 by 1.83 m) were mounted on a cylindrical calorimeter of liquid hydrogen and cryopumped to at least 5×10^{-3} torr (6.66×10^{-5} N/cm^2). This procedure resulted in a heat flux of 23 Btu per hour per square foot (261,000 J/(hr) (m^2)) for an external temperature of 70°F (294°K). In simulated space tests, panels evacuated by outside vacuum resulted in a heat flux of 0.86 Btu per hour per square foot (9770 J/ (hr) (m^2)) with outside surfaces at 70°F (294°K). Author

N68-18082*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
MOLECULAR RADIATION AND ITS APPLICATION TO DIAGNOSTIC TECHNIQUES
R. Goulard (Purdue Univ.), ed. 8 Jan. 1968 479 p refs Presented at Specialists Conf., Huntsville, Ala., 5–6 Oct. 1967
(NASA-TM-X-53711) CFSTI: HC $3.00/MF $0.65 CSCL 20M

In the conference papers presented, attention is focused on various aspects of rocket base heating problems, and on the behavior of liquid propellant rocket jet plumes. For individual titles, see N68-18083 through N68-18114.

N68-18083*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.
INTRODUCTION TO THE PROBLEM OF ROCKET BASE HEATING, AND TO THE BEHAVIOR OF LIQUID PROPELLANT ROCKET JET PLUMES
Werner K. Dahm *In its* Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 4–16 refs (See N68-18082 08-33)

The two complex problems associated with predicting the radiation coming from a rocket jet configuration are identified as (1) the fluid dynamics problem of describing the shape and thermodynamic state of the jet or jet cluster at various altitudes, and determining the flows with chemical reactions; and (2) the problem of describing the radiation of an inhomogeneous gas mass of given thermodynamic state. Rocket jet plumes under sea level conditions are discussed and depicted for the LOX–alcohol jets of the Redstone–Mercury, the LOX–kerosene jets of the Atlas, and the LOX–LH_2 jets of the Saturn 5 second stage. The profound effect of altitude on the appearance of jet plumes is described in reference to observations made of the Saturn 1 first stage at lift-off, and at 14 km, 30 km, and 50 km; the first stage is powered by eight LOX–kerosene engines. M.G.J.

N68-18090*# General Dynamics/Convair, San Diego, Calif.
RADIATION MODEL FOR NONSCATTERING ROCKET EXHAUST GASES
J. A. L. Thomson *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 137–163 refs (See N68-18082 08-33)

A model for calculating the spectral distribution of the heat transfer from an inhomogeneous volume of high temperature water vapor, carbon dioxide, and carbon monoxide is described. The method uses the statistical band model to evaluate the mean transmission over relatively broad spectral intervals and a modification of the Curtis–Godson approximation to account for the gas

inhomogeneity along the line of sight. The effects of both collision and Doppler broadening are included. Emphasis is placed on introducing approximation techniques to reduce computation times. The sensitivity of the predicted radiance both to the approximations inherent in the model and to the present uncertainties in the values of the various model parameters is evaluated for a wide variety of conditions. Author

N68-18091*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

REVIEW OF EXPERIMENTAL VERIFICATION OF THE CURTIS-GODSON APPROXIMATION FOR INFRARED SPECTRAL RADIATION FROM HIGH TEMPERATURE GASES

Burton Krakow and Harold J. Babrov *In its* Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 164-183 refs (See N68-18082 08-33)

Details are given on experimental investigations of inhomogeneous hot gases made at three different laboratories, which indicate that in all cases the Curtis-Godson and band model techniques for calculating transmittances and radiances appear to have sufficient accuracy. The experiments involved: (1) Infrared spectral transmittances of inhomogeneous hot samples of H_2O and CO_2 were measured, using inhomogeneous paths composed of a series of smaller homogeneous paths. The measured transmittance of each inhomogeneous path was compared with a transmittance calculated from the homogeneous zonal transmittance. The measured and calculated inhomogeneous transmittances concurred to within about 0.02. (2) Measured radiances of combustion products above the flames from an array of burners were correlated with calculated values obtained. (3) Radiances of hot water vapor and hot hydrogen fluoride samples with continuous temperature distributions were studied in both flames and furnace-heated gas cells. M.G.J.

N68-18092*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

RADIATIVE HEAT TRANSFER CALCULATIONS FOR SATURN EXHAUST PLUMES

John E. Reardon (Hayes Intern. Corp., Birmingham, Ala.) and Robert M. Huffaker *In its* Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 184-218 refs (See N68-18082 08-33)

The basic methods developed to predict the radiative heat transfer from the exhaust plumes of Saturn vehicles are described, and typical results are presented to assist in evaluating the applicability of the methods used. In addition, the development of computer programs presently used is briefly reviewed, and the capabilities of the latest program are described. To provide a more accurate prediction method, NASA/MSFC sponsored research for inhomogeneous radiance calculations using band model representations for the radiating species of interest in the Saturn vehicles. These methods have been used to predict the radiative transfer for the upper stages of the Saturn vehicle. Author

N68-18093*# Philco-Ford Corp., Newport Beach, Calif. Aeronutronics Div.

EMITTANCE AND RADIANCE CALCULATIONS FOR SOLID PROPELLANT ROCKET EXHAUSTS

D. J. Carlson and A. J. Laderman *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 219-236 refs (See N68-18082 08-33)

The phenomenology of solid propellant plumes is reviewed with emphasis on prediction of spectral radiancy. Sample calculations are presented and compared with experimental values, and important uncertainties noted. Author

N68-18095*# Geophysics Corp. of America, Bedford, Mass.

REMOTE SENSING AND INVERSION TECHNIQUES: STATE OF THE ART

J. I. F. King *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 253-268 (See N68-18082 08-33) (Contract NAS5-3352)

The electromagentic radiation emitted by a radiating system is a function of the physical state of the emitter. Mathematically, the externally viewed field is an integral transform of a state function such as temperature over depth in the medium. Thus, the internal state is given by the inverse transform of the remotely sensed radiation field. The problems associated with inversion are (1) non-uniqueness of the inferred profiles, (2) proper choice of representational set for the internal state function, and (3) the noise problem. The attempts to cope with these difficulties in the development of modified linear and nonlinear inversion techniques are reviewed. Furthermore, it is shown how the radiative transfer implications of the nonlinear inversion method lead to a formulation of a new wave theory of radiative transfer. Finally, a connection is established between the upwelling intensity and the radiative constraints operative internally to produce the observed pattern. Author

N68-18096*# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

STATISTICAL INVERSION METHOD FOR THE SOLUTION OF INTEGRAL EQUATIONS OF THE FIRST KIND

E. R. Westwater and O. N. Strand *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 269-276 refs (See N68-18082 08-33)

The statistical minimum-rms inversion method for solving the integral equation of radiative transfer is summarized and discussed. The accuracy attainable by using this method to infer profiles is shown to be a function of the kernel of the equation, the measurement noise level, and the a priori statistical knowledge of the profile. Examples are given of the application of the method to remote inference of the vertical temperature distribution from microwave measurements of oxygen thermal emission. Author

N68-18100*# Rocketdyne, Canoga Park, Calif.

TEMPERATURE AND CONCENTRATION MEASUREMENTS IN MODEL EXHAUST PLUMES USING INVERSION TECHNIQUES

William Herget *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 359-379 refs (See N68-18082 08-33)

In the technique described, the spectral radiance and spectral transmittance of infrared active exhaust species are measured along a series of coplanar, chordal lines of sight spanning the exhaust. The data thus obtained allow equations describing the radiant energy transferred through the exhaust to be solved either directly or by inversion methods of the radial distributions of spectral radiance and spectral emissivity. From these latter two quantities the radial distributions of temperature and partial pressure are calculated. This technique has been used to map a portion of the exhaust plume of a 1000 pound thrust rocket motor for the propellants liquid oxygen/kerosene and liquid oxygen/alcohol. Author

N68-18106*# Cornell Univ., Ithaca, N. Y. Sibley School of Mechanical Engineering.

THE RELEVANCE OF FREQUENCY AVERAGED PROPERTIES

S. C. Traugott *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 428-431 ref (See N68-18082 08-33)

It is pointed out that the problem of radiative heat transfer is distinguished from that of detection or temperature inversion by the

fact that the heat transfer rate is an integral over all frequencies. This means that spectral characteristics are not of primary interest, and may be regarded as an obstacle to simple and rapid heating estimates. The use of gross spectral simpliciations is discussed, and an example is given to illustrate the idea of finding some relation to nonspectral calculations. This example involves a homogeneous real gas and the most crude nonspectral model of them all, the gray gas. Author

N68-18107*# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.

GAS EMISSIVITY MODEL FOR RADIATIVE TRANSFER CALCULATIONS

Adel F. Sarofim *In* NASA Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 432–435 refs (See N68-18082 08-33)

Consideration is given to a mixed gray gas approximation model, which provides an accurate description of total emissivity and yet retains a functional form simple enough for calculations in which interaction of radiation with convection and/or other energy terms is important. The model permits the expression of radiative flux in different configurations as a weighted sum of geometrical factors which have been evaluated and tabulated for gray gas exchange. Another advantage cited is that the number of constants needed adequately to describe total emissivity is far smaller than that required for describing spectral emissivity. M.G.J.

N68-18111*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

FORUM. QUESTION 1: HEAT TRANSFER AND FLOW FIELD SOLUTIONS

In its Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 451–453 (See N68-18082 08-33)

Questions are raised regarding the accuracy of radiation heat transfer solutions in rocket plume calculations, with particular reference to the temperature field of a Saturn S-2 plume. These pertain to the absolute level of confidence in the heat transfer results, assuming that the flow field is completely known; the largest uncertainties besides gas properties; and the work needed to be done in order to improve the current 25% accuracy in liquid and solid propellant plume radiation. M.G.J.

N68-18112*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

FORUM. QUESTION 2: REQUIREMENTS, POSSIBILITIES AND PROMISES OF INVERSION TECHNIQUES FOR ROCKET EXHAUST PLUME TECHNOLOGY

In its Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 454–458 (See N68-18082 08-33)

The advantages and disadvantages of the linear and nonlinear temperature inversion methods are assessed, and the opinion is offered that no completely satisfactory technique has been developed. Vertical temperature profile determination is discussed from the viewpoint of who wants the information and the degree of accuracy required, with particular reference made to numerical weather forecasting. The question was also raised as to whether the experience acquired in meteorological satellite measurements could be transferred to the probing of rocket plumes. The point is made that cross-beam spectroscopy and inversion techniques seem to be complementary since the crossed-beam method works best for inhomogeneous and time-varying distribution of radiation sources, whereas inversion techniques work for smooth distributions. M.G.J.

N68-18113*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

FORUM. QUESTION 3: RELEVANCE OF LABORATORY EXPERIMENTS TO ACTUAL RADIATING FLOWS

In its Mol. Radiation and its Appl. to Diagnostic Tech. 8 Jan. 1968 p 459–476 (See N68-18082 08-33)

A short duration technique developed for base heating model tests is described. Based on a shock tube principle, two supply tubes, closed by diaphragms, are filled with compressed gaseous fuel and oxidizer selected to yield the same combustion products as the desired liquid propellants. When the diaphragms are cut, the propellants flow into the combustion chamber, are ignited, and discharged through the exhaust nozzles. A wave diagram is included to depict the flow process. Instrumentation techniques and test procedures are also detailed. The question of how to use the radiation characteristics and radiative heating component measurements is examined in terms of (1) a fluid mechanics problem which determines the shape of the plume and its temperature, density, and composition distributions; and (2) the radiative transfer problem of emission and absorption in this inhomogeneous volume. The methods used in actual practice to obtain design numbers of full scale plume radiation are discussed. M.G.J.

N68-18115*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

COMBUSTION INSTABILITY WITH FINITE MACH NUMBER FLOW AND ACOUSTIC LINERS

Richard J. Priem and Edward J. Rice Washington 1968 28 p refs To be presented at the 12th Intern. Symp. on Combust. Spon. by the Combust. Inst., Poitiers, France, 14–20 Jul. 1968 (NASA-TM-X-52412) CFSTI: HC $3.00/MF $0.65 CSCL 21B

Combustion instability phenomena are examined theoretically using a small amplitude, linear analysis. Conservation equations are solved for finite axial gas velocities in the combustion chamber. Transverse waves with axial variations were considered. Concentrated combustion near the injector face was assumed. The general wave equations are solved for specific boundary conditions at the end of the chamber (nozzle entrance), walls of the chamber (acoustic liners) and the injector (combustion zone). Author

N68-18122*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

A THREE-DIMENSIONAL ANALYSIS OF THE EFFECTS OF HEAT GENERATION IN PLATES

Robert R. McWithey Washington Jan. 1968 27 p refs (NASA-TN-D-4326) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A method for determining three-dimensional steady-state temperature distributions is presented for plates in which heat is generated and conducted throughout the plate material. The solution for the temperature distribution is given in terms of a power series with respect to the plate thickness coordinate. The coefficients of the power series are dependent upon the temperature distribution over the plate surfaces. Specific attention is given to the determination of temperature distributions and plate deformations resulting from constant heat generation and from the absorption of electromagnetic radiation. Author

N68-18163# European Organization for Nuclear Research, Geneva (Switzerland).

TEMPERATURE MEASUREMENTS IN THE CERN 1 m^3 HEAVY LIQUID BUBBLE CHAMBER

K. H. Eberle *In its* Intern. Colloq. on Bubble Chambers, Vol. 2 Aug. 1967 p 413–424 ref (See N68-18147 08-11)

Temperature measurements were made in the Cern heavy liquid bubble chamber to obtain data on the dynamic behavior of the chamber, and to determine parameters for improving its

temperature regulation. Measurements are made with the chamber filled with Freon 13 B 1 (CF_3Br), cycling under normal pressure conditions at a rate of 2.3 s. Data on two kinds of temperature distributions are analyzed; one in the different vertical planes, and one in the horizontal direction. For the vertical plane, results indicated that: (1) no matter what gradient is set externally, the liquid temperature is highest in and around the center of the chamber; (2) the liquid temperature is lowest in the lower half of the chamber, but not quite at the bottom; (3) the lowest temperature difference found between any two test points in one single plane was 0.8°, the highest was 1.8°; (4) the lowest temperature difference found between any two test points in the chamber was 1.5°, the highest was 2.3°; (5) the temperature of the liquid rises uniformly with increasing flash energy; (6) the most uniform distribution, comparing different gradient settings, was obtained with gradients of −2° and −4°. For the axial direction the following results were obtained: (1) a steady temperature drop was observed between the window and the membrane, its average value being 0.8°; and (2) the lowest drop observed was 0.6°, the highest 1.2°.
S.C.W.

N68-18165 France. Ministere de l'Air, Paris.
STUDY OF THE EFFECT OF ULTRASOUND ON THE COMBUSTION OF A JET OF LIQUID HYDROCARBONS [ETUDE DE L'EFFET DES ULTRA-SONS SUR LA COMBUSTION D'UN JET D'HYDROCARBURES LIQUIDES]
Louis Charpenet Serv. de Doc. Sci. et Tech. de l'Armament 1966 89 p refs In FRENCH *Its* Publ. Sci. et Tech. No. 424

Important turbulence effects generated by sonic and ultrasonic vibrations were investigated in terms of the combustion of a jet of liquid hydrocarbons; and thermal and chemical modifications to the flame that resulted in the combustion are reported. Equipment used and measurement techniques are detailed for both the thermal and chemical studies. An investigation of combustion generation is reported, and hypotheses are offered for the observed phenomena.
Transl. by M.W.R.

N68-18196*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PRESSURE-RISE CHARACTERISTICS FOR A LIQUID HYDROGEN DEWAR FOR HOMOGENEOUS, NORMAL GRAVITY QUIESCENT, AND ZERO GRAVITY TESTS
Kaleel L. Abdalla, Thomas C. Frysinger, and Charles R. Andracchio Washington Sep. 1965 35 p refs (Declassified)
(NASA-TM-X-1134) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The pressure-rise characteristics for a liquid-hydrogen Dewar were obtained by utilizing a scientific passenger pod on an Atlas intercontinental ballistic missile during a 21-minute gravity free flight. Results were compared with those from homogeneous and normal-gravity quiescent tests. Residual pod rotation created an undesirable acceleration field on the Dewar of approximately 10^{-3} g throughout the weightless flight time. Temperature instrumentation indicated wall drying during this period. The resultant pressure-rise characteristics were similar to those for the normal-gravity test.
Author

N68-18206#. Naval Research Lab., Washington, D. C.
INVESTIGATION OF SOLID/LIQUID INTERFACE TEMPERATURES VIA ISENTHALPIC SOLIDIFICATION Interim Report
M. E. Glicksman and R. J. Schaeffer 13 Oct. 1967 25 p refs
(ARPA Order 418)
(NRL-6600; AD-663555)

Isenthalpic solidification of a pure supercooled liquid is shown to result in either a two-phase solid/liquid mixture in invariant equilibrium or a single-phase, totally solid material in univariant equilibrium, depending on the level of supercooling prior to solidification. The critical supercooling above which univariant equilibrium is obtained is large for metals (hundreds of centigrade degrees) but much smaller for certain molecular substances. Experiments on white phosphorus (alpha P4) show that the critical supercooling (25.6C) can be reached, and exceeded, easily. Solidification rate measurements taken above and below the critical supercooling for P4 show that the solid/liquid interface temperature varies smoothly with melt supercooling, although light-scattering experiments indicate that rapid changes occur in the extent of the dendritic zone as the critical supercooling is approached and exceeded. A method for extracting interface attachment kinetics from solidification rate data was examined in detail and applied to our rate measurements on P4. We find that above about 9C supercooling, P4 solidifies with linear attachment kinetics having a rate constant of 17.7 plus or minus 0.4 cm/sec C. Below about 1C supercooling, P4 solidifies with a faceted morphology indicative of layer-passage limited kinetics. Between 1C and 9C supercooling, transitional growth kinetics occur. These results are in qualitative agreement with the crystal growth theory of Cahn, et al., which predicts that attachment kinetics should change as the driving force for crystal growth is varied by substantial amounts.
Author (TAB)

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N68-17266# Philippine Atomic Energy Commission, Manila. Classification and Information Branch.
IRON 59 (Fe^{59}): A LITERATURE SEARCH
Jul. 1967 76 p refs
(PAEC(A)IN-672)

A bibliography of 398 entries is presented on the properties and uses of iron-59. The references cited were abstracted in Nuclear Science Abstracts during the period March, 1947 to September, 1966.
NSA

N68-17397# Rolls-Royce, Ltd., Derby (England). Aero Engine Div.
A REVIEW OF AERO ENGINE SMOKE EMISSION
B. Toone [1967] 41 p Symp. on Combust., Cranfield, Engl., Apr. 1967

An investigation is made of smoke emission from gas turbine engines and the methods used to measure smoke concentrations and the mechanisms responsible for smoke production are discussed. Data are given which show the relative importance of fuel quality, burner characteristics, and aerodynamic mixing in the combustion chamber. Inlet conditions to the combustion chamber are also important. The development of engines with high operating pressures and lower pressure loss factors has produced higher engine smoke levels, but so far it has been impossible to reduce smoke to satisfactory levels by combustion chamber modifications. The effect of fuel quality is small compared with the changes which can normally be made by improving air and fuel mixing. Fuel additives show promise in reducing exhaust smoke but they contaminate the engine. The best solution is to properly design the combustion chamber.
R.N.A.

N68-17609*# Techtran Corp., Glen Burnie, Md.
BOOK REVIEW OF TEXTBOOK ON FIRE PREVENTION [UCHEBNIK PO PROTIVOPOZHARNOY TEKHNIKE]
M. I. Bobrovnikov Washington NASA Feb. 1968 4 p refs Transl. into ENGLISH from Khim. i Tekhnol. Topliv i Masel (Moscow), v. 10, 1967 p 62–63
(Contract NASw-1695)
(NASA-TT-F-11542) CFSTI: HC $3.00/MF $0.65 CSCL 13L

The book "Principles of Fire Prevention in the Petroleum and Petro-Chemical Industry" is reviewed. The textbook, consisting of six parts, presents the basic concepts and physical-chemical principles of the process of combustion, presents a description of various types of production as concerns their fire danger and expounds the principal measures used to eliminate causes for the incidence and spread of fires, evacuation of personnel and materiel in case of fire, effective methods for putting out fires, etc. However, the book contains a number of defects: certain obsolete norms are included, the latest fire prevention methods are omitted, and certain areas are inaccurately covered. Specific faults are listed.
Author

N68-17621*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-48, VOLUME 3 FOR THE PERIOD OCTOBER 1, 1967 TO NOVEMBER 30, 1967. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT
31 Dec. 1967 298 p refs
(Contract NAS7-100)
(NASA-CR-93204; JPL-SPS-37-48, V. 3) CFSTI: HC $3.00/MF $0.65 CSCL 22

Summary information is presented on the various research projects being conducted on advanced space systems. The main areas covered are system analysis research, computation methods, systems design and integration, spacecraft power, guidance and control, material and electronics parts engineering, solid propellant engineering, space instruments and science data systems, communication systems, and spacecraft telemetry and command systems. Among the reports included are: (1) An analysis of de-orbit maneuver execution errors in which the effects of errors in the initial conditions of a capsules descent trajectory are considered. (2) The feasibility study of a 30-W/lb roll-up solar array to be deployed after launch through a roll-out technique is discussed, and details of the proposed mechanical design are depicted. (3) Propulsion studies of liquid-metal MHD conversion and clustered ion engine systems are reported. (4) Evaluation data are presented on photo-sensor, linear approximation of a mass spectrometer sweep voltage, and possibility of permafrost features on the Martian surface. (5) Interference effects on a binary communication channel using known signals are analyzed.
B.S.D.

N68-17634# Dayton Univ., Ohio. Research Inst.
DEVELOPMENT AND EXPERIMENTAL EVALUATION OF A RETRIEVAL SYSTEM FOR AIR FORCE CONTROL-DISPLAY INFORMATION Final Summary Technical Report, 30 Jun. 1966–1 Jul. 1967
Anthony Debons, Frederic L. Scheffler, and John D. Snide Wright-Patterson AFB, Ohio AF Flight Dyn. Lab. Nov. 1967 177 p refs
(Contract AF 33(615)-5310)
(AFFDL-TR-67-19; AD-663756)

A proposed classification system was studied to determine its efficacy to the Air Force Control-Display Area. Based on negative outcomes from a logical assessment of the proposed system, an alternate system was proposed to include the coordinate index concept. Upon development of a thesaurus and an index system on 106 documents in the VSTOL/VTOL area, an experiment was conducted to determine the acceptance and effectiveness of the system on professional workers using the system. Findings revealed that the coordinate system was acceptable to the user and that it provided for the retrieval of relevant documents beyond that expected by chance. The study suggests that the coordinate index system and the present measures used to study its effectiveness provide a rationale for further experimentation which can expand the base of the system to meet the need of the control-display area.
Author (TAB)

N68-17641# International Centre for Theoretical Physics, Trieste (Italy).
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS Interim Report, Oct. 1966–May 1967
May 1967 34 p
CFSTI: HC $3.00/MF $0.65

This activity report summarizes the educational program, e.g. fellowships and the Advanced School of Physics the courses of which are mentioned and the lecturers and participants cited. Preprints and reports issued between October 1966 and May 1967 are listed.
ESRO

N68-17656# RAND Corp., Santa Monica, Calif.
RISK AND THE AEROSPACE RATE OF RETURN
Irving N. Fisher and George R. Hall Dec. 1967 77 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5440-PR; AD-663726)

The relationship between risk and profit is explored and a method for measuring the risk component of corporate earnings is developed. Average risk premiums and risk-adjusted rates of return are estimated for aerospace and 10 other industry groups. Risk is defined as the probability that earnings in some future period will differ from an anticipated value. Assuming that, on average, profit expectations are fulfilled, risk can be measured by characteristics of the earnings distribution. Standard deviation and skewness are the statistical variables used to measure the firms risk exposure. A statistically significant relationship is found between average rates of return on net worth and both standard deviation and skewness. Average risk adjusted rates of return are estimated for each industry group and compared with nominal rates of return. The risk-adjusted rates of return for drugs and aerospace are noticeably larger than those for the other industry groups. This finding implies that, for this sample, above-average rates of return in the aerospace group cannot be explained by above-average risk exposure.
Author (TAB)

N68-17681# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 4, NUMBER 2 Monthly Review of Selected Foreign Scientific and Technical Literature
Feb. 1968 168 p refs

CONTENTS:

1. ELECTROSLEEP AND ELECTROANESTHESIA—THEORY AND CLINICAL EXPERIENCE A. Iwanovsky and C. H. Dodge p 1–64 refs (See X68-17682 08-04)

2. THEORY OF PLATES AND SHELLS IN FLIGHT-VEHICLE DESIGN V. Klein p 65–84 refs (See X68-17683 08-32)

3. DIAGNOSTIC USE OF THE FLUORESCENT-ANTIBODY METHOD IN THE USSR L. Perkins p 85–101 refs (See X68-17684 08-04)

4. INTEROBS AND THE DETERMINATION OF SATELLITE ALTITUDE DENSITIES D. W. Michaels p 102–114 refs (See X68-17685 08-13)

N68-18120*# Washington Univ., St. Louis, Mo. Dept. of Economics.

TOWARD A PEACETIME ECONOMY

Murray L. Weidenbaum Feb. 1968 25 p refs Presented at the Dept. of Econ. Seminar Ser. on the Cost of Conflict, Kalamazoo, Mich., 28 Feb. 1968 *Its* Working Paper 6803

(Grant NsG-342)

(NASA-CR-93356) CFSTI: HC $3.00/MF $0.65 CSCL 05C

Public planning in a peacetime economy is considered to provide information for policy-makers concerned with the role of the national space program in a post-Viet Nam context. Earlier defense cutbacks are discussed, and mention is made of efforts aimed at alleviating existing problems that could be adapted and expanded to cover specific problems arising from disarmament. Consideration is given to shifting to peacetime production, converting defense industries, and the adaptability of American labor. Tax reduction, monetary and financial policy adjustments, rapid and long-run expansions in government programs, and federal aid to state and local governments are discussed; as are aid to veterans, defense workers, areas, and companies. Four major components suggested for an effective initial economic adjustment policy following peace in Viet Nam are tax reduction, a general ease in monetary policies, an increase in government transfer payments, and an acceleration in the rate of space and other existing programs. M.W.R.

N68-18130*# Washington Univ., St. Louis, Mo. Dept. of Economics.

LONG TERM IMPACTS OF BIG TECHNOLOGY

Murray L. Weidenbaum Feb. 1968 17 p refs Presented at the 6th Goddard Mem. Symp., Washington, D. C., 4 Mar. 1968 *Its* Working Paper 6801

(Grant NsG-342)

(NASA-CR-93355) CFSTI: HC $3.00/MF $0.65 CSCL 05C

It is pointed out that the close, continuing relationship between the Federal Government and its major suppliers of large technical systems is resulting in a convergence between the two, which is reducing much of the distinction between the public and private sectors. To a substantial degree, the government is taking on the traditional role of the private entrepreneur while the companies are becoming less like other corporations and more like government agencies or arsenals. The recommendation is made that government procurement policies need to be modified in order to halt the erosion of the basic entrepreneurial character of the firms that undertake large-scale developmental programs for government agencies. Second thoughts need to be given before the Nation agrees to the almost uncritical demands for extending the use of the government-oriented corporations to other parts of the public sector. Author

N68-18135*# National Academy of Sciences-National Research Council, Washington, D. C.

SPACE APPLICATIONS SUMMER STUDY, 1967. VOLUME 1: CENTRAL REVIEW COMMITTEE CONCLUSIONS AND RECOMMENDATIONS AND SUMMARIES OF PANEL REPORTS Interim Report

Jan. 1968 72 p Prepared for NASA

(NASA-CR-91251) GPO: HC $0.45; CFSTI: MF $0.65 CSCL 22A

Future usefulness of satellites in practical earth-oriented applications were examined in terms of technical feasibility, costs, and benefits to be derived. These investigations were accomplished by 11 panels comprising a Central Review Committee whose fields were (1) meteorology, (2) hydrology, (3) oceanography, (4) forestry, agriculture, and geography, (5) geology, (6) geodesy, (7) cartography, (8) sensors, (9) point-to-point communication, (10) broadcasting, and (11) navigation and traffic control. M.W.R.

Collections of NASA Documents

NASA is depositing its technical documents and bibliographic tools in eleven Federal Regional Technical Report Centers. Each center, located in one of the organizations listed below is prepared to furnish the general public such services as personal reference, interlibrary loans, photocopy service, and assistance in obtaining retention copies of NASA documents.

California: University of California, Berkeley
Colorado: University of Colorado, Boulder
District of Columbia: Library of Congress
Georgia: Georgia Institute of Technology, Atlanta
Illinois: The John Crerar Library, Chicago
Massachusetts: Massachusetts Institute of Technology, Cambridge
Missouri: Linda Hall Library, Kansas City
New York: Columbia University, New York
Pennsylvania: Carnegie Library of Pittsburgh
Texas: Southern Methodist University, Dallas
Washington: University of Washington, Seattle

NASA publications are currently being forwarded to the public libraries in the cities listed below:

California: Los Angeles and San Diego
Colorado: Denver
Connecticut: Hartford
Massachusetts: Boston
Michigan: Detroit
Minnesota: St. Paul and Minneapolis
Missouri: Kansas City and St. Louis
New Jersey: Trenton
New York: Brooklyn, Buffalo, Rochester and New York
Ohio: Cleveland, Cincinnati, Dayton, Toledo and Akron
Oklahoma: Oklahoma City
Tennessee: Memphis
Texas: Fort Worth and Dallas
Washington: Seattle
Wisconsin: Milwaukee

In addition, NASA regularly sends its publications to the Enoch Pratt Free Library located in Baltimore, Maryland and the Wilmington Institute Free Library, Wilmington, Delaware.

An extensive collection of NASA and NASA-sponsored scientific and technical publications available to the public for reference purposes is maintained at the Technical Information Service, American Institute of Aeronautics and Astronautics, 750 Third Avenue, New York, New York 10017.

National Aeronautics and Space Administration
WASHINGTON, D. C. 20546

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION

01U 001 01 53 2BU 68106 01386
DUKE UNIVERSITY LIBRARY
PUBLIC DOCUMENTS DIVISION
DURHAM, NORTH CAROLINA 27706

ATT DOCUMENTS LIBRARIAN

N TIONS

d

TECHNICAL NOTES: Information less broad in scope but nevertheless of importance as a contribution to existing knowledge.

TECHNICAL MEMORANDUMS: Information receiving limited distribution because of preliminary data, security classification, or other reasons.

CONTRACTOR REPORTS: Scientific and technical information generated under a NASA contract or grant and considered an important contribution to existing knowledge.

TECHNICAL TRANSLATIONS: Information published in a foreign language considered to merit NASA distribution in English.

SPECIAL PUBLICATIONS: Information derived from or of value to NASA activities. Publications include conference proceedings, monographs, data compilations, handbooks, sourcebooks, and special bibliographies.

TECHNOLOGY UTILIZATION PUBLICATIONS: Information on technology used by NASA that may be of particular interest in commercial and other non-aerospace applications. Publications include Tech Briefs, Technology Utilization Reports and Notes, and Technology Surveys.

Details on the availability of these publications may be obtained from:

SCIENTIFIC AND TECHNICAL INFORMATION DIVISION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546